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ELEMENTS

OF

MINERALOGY.

VOL. II.

ELEMENTS

OF

MINERALOGY.

BY

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OF THE ACADEMIES OF STOCKHOLM, UPSAL, BERLIN, MANCHESTER, PHILADELPHIA, &C.

SECOND EDITION,

WITH

CONSIDERABLE IMPROVEMENTS AND ADDITIONS.

VOL. II.

SALTS, INFLAMMABLES, AND METALLIC SUBSTANCES.

LONDON:

PRINTED FOR P. ELMSLY, IN THE STRAND.

M,DCC,XCVI.

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PART SECOND.

CHAPTER I.

SALINE SUBSTANCES.

11. Nitre

Famil

Var.

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Of

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ERRATA.

Only the most material are here inserted; a few others, easily amendable, are submitted to the reader's indulgence.

Page	Line
ix,	21, *after* subsidiary *add* Ores.
xiii,	32, *f.* Plumose *r.* Antimonial Ores.
6,	*ult. f.* that *r.* the.
9,	5, *f.* Alum *r.* Alum.—*The Reader is requested to make this correction in the succeeding pages wherever it may occur.*
27,	26 *and* 27 *to be read in continuation.*
29,	31, *d.* erde, *which is twice repeated.*
21,	8, *f.* parallelipipeds of a sharp astringent taste *r.* parallelopipeds of a sharp astringent taste
24,	27, *f.* interspersted *r.* interspersed.
25,	28, *after* Matrix *add* a comma.
26,	5, *f.* Rochefochaut *r.* Rochefoucault.
34,	6, *f.* lanigunous *r.* lanuginous.
47,	28, *f.* 096 *r.* 0,96.
64,	2, *f.* 4 *r.* V.
65,	13, *f.* smlle *r.* smell.
66,	21, *f.* ppermaceti *r.* Spermaceti.
69,	2, *f.* 5 *r.* VI.
70,	15, *f.* insouble *r.* insoluble.
——	29, *f.* Sulphur *r.* Native Sulphur.
75,	18, *f.* to *r.* or.
77,	9, *f.* course *r.* coarse.
81,	5, *after* Distillation *add a comma, and dele that after it.*
95,	24, *after* pure *add* sulphurated.
——	25, *f.* scorisy *r.* scorify.
103,	4, *d. the comma after* perfect.
117,	7, *f.* 3053 *r.* 3035.
——	10, *f.* Huelgrat *r.* Huelgoat.
142,	25, *f.* diehoedral *r.* dihedral.
145,	*antepenult, f.* Hessed *r.* Hesse.
155,	19, *f.* or *r.* of.
157,	*penult f.* substance *r.* substances.
159,	25, *f.* shot *r.* short.
171,	*penult. f.* Calorific *r.* colorific.
182,	8, *f.* 266 *r.* 139.
——	23, *f.* glassy *r.* glossy.
192,	17, *f.* sided *r.* sized.
211,	*ult. d. the comma after* mass.
215,	20, *f.* 45 *r.* 4,5.
226,	22, *f.* consists *r.* consist.
232,	24, *f.* bluish, greenish, *r.* bluish and greenish.
238,	7, *f.* oilve *r.* olive.
239,	17, *f.* *Red r. Rothe.*
245,	8, *f.* precipiated *r.* precipitated.
277,	*penult. f.* Nickelo *r.* Nickel.
281,	1, *f.* Chap. XV. *r.* Chap. XVI. *a similar error prevails in the following chapters to* XXII
285,	26, *d. the comma after* precipitable.
293,	19, *f.* 45 *r.* 4,5
295,	11, *et alibi, f.* Barsolenite *r.* Baroselenite.
304,	4, *f.* dard *r.* dark
311,	*antepenult f.* Tartariated *r.* Tartarinated.
315,	24, *f.* Tungstenic *r.* Tungostenitic.
353,	31, *f.* 275 *r.* 357
378,	17, *f.* Antonated *r.* Antimoniated.
——	27, *after* residuum *add* was left.
381,	25, *et alibi f.* of *r.* off.
386,	21, *f.* Mgnesiated *r.* Manganesiated.
397,	19, *f.* 257 *r.* 357.
401,	21, *f.* it *r.* them.
406,	4, *f.* 962 *r.* 690.
——	20, *f.* graese *r.* grease.
447,	9, *f.* Cales *r.* Calces.
449,	10, *f.* 33d *r.* 13th.
510,	30, *f.* their *r.* its.
——	*ult. f.* 2, Chy An. 397 *r.* 2 Chy. An. 1793, 397.
517,	*ult. f.* 135 *r.* 235.
518,	25, *f.* lighter *r.* higher.

ADDITIONS.

Some experiments seem to prove the *Compact Red Copper Ore*. p. 135. to consist of Copper impregnated with Carbon.

After the impression of the last sheet, I received through the goodness of the Author, Mr *Hatchet's* valuable paper on the Molybdenated Lead of *Carinthia*.—He has shewn that the specific Gravity of the Ore freed from all *visible* earthy particles is 5,092. And when purified by dilute Nitrous Acid 5,706.—And that 100 parts of the purified Ore contain 58,4 of Lead, 38 of Molybdenic Acid, and 2,08 of Calx of Iron, with a few particles of Silex.

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MINERALOGY.

PART II.

SALINE SUBSTANCES.

ALL thoſe ſubſtances that are arranged under this denomination require leſs than 200 times their weight of water to diſſolve them.

CHAP. I.

OF ACIDS.

THE acids that occur in the Mineral Kingdom, either diſengaged or combined, are, 1ſt. The AERIAL, otherwiſe called CARBONIC ACID, or FIXED AIR. 2d. The VITRIOLIC. 3d. The NITROUS. 4th. The MARINE or MURIATIC. 5th. The SPARRY or FLUOR. 6th. The PHOSPHORIC. 7th. The ARSENICAL. 8th. The BORACIC. 9th. The MOLYBDENOUS. 10th. The TUNGSTENIC. 11th. The SUCCINOUS.

The AERIAL ACID is found either in an aerial ſtate, as in mines, caverns, volcanic craters, pits, wells, or combined with water, in mineral or common ſprings, or with various earths, as the Calcareous, Barytic, Stronthian, Muriatic, and Argillaceous, or with metallic ſubſtances, as in various ores. It is ſufficiently diſtinguiſhed by its inability to ſupport life, or flame, its ability to unite with water, and of precipitating lime from lime water in an effervefcent ſtate, and its inability to effect a precipitation of lime from its ſolution in any other acid.

The VITRIOLIC ACID is capable of exiſting at leaſt in two ſtates, namely, the imperfectly acidified, and then called the SULPHUREOUS ACID, or the perfectly acidified, forming the common vitriolic acid, ſimply ſo called. The ſulphureous acid exiſts, diſengaged in the craters of volcanos, in various ſolfaterras, and in, and over, hot waters in the neighbourhood of volcanos, or exhaling from recent lavas.

The common vitriolic acid, I believe, has never been found in nature free from all combination, though it may unite to ſome bodies beyond the point of ſaturation. It is true Mr. BALTASSARI ſays, he found ſome dry concentrated vitriolic acid adhering to ſelenite, in a grotto in MONTE ZACCOLINO, near SIENNA; but this has been fully diſproved by the ſubſequent obſervations of Mr MURRAY, in the 37th. vol. of the Memoirs of STOCKHOLM, and of Mr DOLOMIEU, in his Notes on BERGMAN DE PROD. VOLCAN. p. 88. In a combined ſtate it is found in various ſalts, earths and ores.

The SULPHUREOUS ACID IN AN AERIAL STATE, is diſtinguiſhable by its peculiar ſmell it

its prompt abſorbability by leſs than one half its bulk of water, the ſmell it then communicates to it, the immediate precipitation of lime water, as well as the diſcoloration of ſyrup of violets, which water thus impregnated can effect.

The NITROUS ACID, has, I believe, been never found in a FREE STATE, except perhaps in charnels and privies, and tho' generally formed of pure air, and mephitic air furniſhed by putrifying ſubſtances, yet, as it has been found in neutral ſalts, ſo circumſtanced that putrefaction can ſcarce be ſuſpected to have taken place, and has alſo been lately artificially formed by Dr. MILNER, without any preceding putrefaction; we can no longer deny it a place among the Mineral Acids.

The MURIATIC ACID, frequently occurs in a combined ſtate, either with alkalis, earths, or metals.

The SPARRY ACID, exiſts principally in fluor ſpar, yet ſome other ſtones, and even ſome metallic ores are often partially impregnated with it.

The PHOSPHORIC ACID, is frequently found in a ſtate of union, not only with calcareous earth, but alſo with various metallic ſubſtances.

The ARSENICAL ACID, has been traced in the ores of other metallic ſubſtances, particularly of cobalt and copper.

The BORACIC ACID, has been found in a diſengaged ſtate in the waters of ſeveral laguni, or lakes of hot mineral waters, near MONTE ROTONDO, BERCHIAIO and CASTELLONUOVO in TUSCANY, in the proportion of nearly nine grains in one hundred of water, by Mr. HOEFFER. Mr. MASCAGNI has alſo found it adhering to ſhiſti, on the borders of lakes, of an obſcure white, yel-

low or greeniſh colour, and cryſtalized in the form of needles. 16 Roz. p. 364. In a combined ſtate, it has been found not only in union with ſoda, but alſo with calx and magneſia, as already ſeen. And a cording to MASCAGNI, alſo with Volalkali 42 Roz. p. 37.

In its free ſtate it is diſtinguiſhable by its flaky appearance, its ſolubility in leſs than twenty times its weight of boiling water; from whence, on cooling, it precipitates for the moſt part, and cryſtalizes in light white ſhining flakes, which when heated, tumefy and vitrify, but the glaſs thus formed, is again ſoluble in water as before. The aqueous ſolution reddens Litmus, but more difficultly and tranſiently ſyrup of violets. This Acid is alſo ſoluble in ſpirit of wine, to whoſe flame it communicates a greeniſh tinge. Its ſpecific gravity is 1,479.

The MOLYBDENOUS ACID, has been EXTRACTED from MOLYBDÆNA, and alſo been found COMBINED in ſome Lead Ores.

The TUNGSTENIC ACID, has been found combined with calcareous earth in TUNGSTEN.

The SUCCINOUS ACID, has been found in mineral coal. Mem. Paris 1781. p. 211.

CHAP.

CHAP. II.

OF ALKALIS.

Of these there are two kinds, the fixed and the volatil.

OF the fixed there are two species, the one generally afforded by the incineration of inland vegetables, and thence called the VEGETABLE ALKALI, (which I call TARTARIN,) the other, extracted from some maritime plants, but most frequently of mineral origin, and thence called MINERAL ALKALI, or SODA, or NATRON. Neither of them is found perfectly disengaged from acids, but combined, at least with fixed air; hence, combined with this air they effervesce with other acids, turn syrup of violets and infusions of turnsole green, and crystalize with the vitriolic, nitrous and marine acids, precipitate earths and metallic solutions, &c. TARTARIN combined with FIXED AIR is seldom found in the earth, except in wells in towns, as at DOWAY, &c, 4 Mem. Scav. Etrang. yet it is said to exist in the aluminous ore of LA TOLFA; and in combination with the Vitriolic, Nitrous and Marine acids, it is found in SPAIN, and the EAST INDIES, as will presently be seen. Indeed, from Mr. BOWLES's account, it would seem as if it were yearly re-produced in certain earths properly exposed to the influence of the atmosphere. BOWLES's SPAIN. p. 79.

NATRON

NATRON, or the Mineral Alkali, frequently occurs in the Mineral Kingdom, not only united with the Vitriolic, Marine and Boracic acids, but even in the more feeble combination into which it enters with fixed air. It appears to be depoſited in large maſſes in various countries, under the ſurface of the earth, from which it is extracted by running waters. Thus it is found after the exhalation of the water, mixed with ſand in the bottom of lakes in HUNGARY, and in the neighbourhood of BILIN in BOHEMIA; it is found at firſt cryſtalized, and afterwards withered on lands recently overflown by that river. It occurs alſo in CHINA, where it is called KIEN, and near TRIPOLI, where it is called TRONA; alſo in SYRIA, ÆGYPT, PERSIA and INDIA. Mr. MORELL lately diſcovered it in SWISSERLAND, aſſociated with Glauber's Salt. It is ſeldom, perhaps never, abſolutely free from a mixture of common ſalt. It frequently oozes out of walls, and cryſtalizes on their ſurface, mixed with calcareous particles, and is then called APHRONITRON.

In its decompoſed ſtate it preſents thin flakes, or a rough duſty powder, of a ſmoke or yellowiſh grey colour, taſting alkaline, and eaſily diſſolving in water. It often accompanies beds of lava. It is ſeparated from Glauber's ſalt, imperfectly by cryſtalization, more perfectly by ſaturating it with diſtilled vinegar, cryſtalizing, and treating the cryſtals with the ſpirit of wine. This will take up the Acetous Salt, and leave the Glauber untouched, or by treating the acetated ſolution with acetated Barytes, and heating the precipitate to redneſs, and weighing it when cold. Its weight will indicate that quantity of vitriolic acid;

acid, and the quantity of this acid will indicate that of the Glauber's salt, as 168 grains of Baroselenite contain as much acid as 100 grains of Glauber's salt dried in a strong red heat, or as 238 grains of crystalized Glauber. It is separated from common salt, by treating the nitrated solution with that of nitrated silver; 235 grains of Muriated silver indicate the presence of 100 grains of common salt. It is also separable by crystalization, but less perfectly.

To distinguish the vegetable from the mineral ALKALI, when in a very small quantity, let the acid of sugar be droped into the solution, with the former it will form a very soluble salt, with the latter a difficultly soluble, and thence apparent. If both be mixed, they may be separated by this means.

VOLALKALI.

As pure Volalkali consists of mephitic (otherwise called azotic, and formerly phlogisticated) air and inflamable air concreted together, in the proportion of nearly four parts of the former and one of the latter, particularly when the latter is in a nascent state, and slowly disengaged, (an accident that must frequently happen in the Mineral Kingdom,) it should seem surprising that Volalkali should not be often formed, tho' from its volatility and solubility, it may seldom be detected. Accordingly, it has been found in some mineral waters by Mr. MALOUIN, Mem. Paris. 1746. and by Mr. CAVENDISH, Philos. Transactions 1767. 2 BERGMAN Erde Kugel, 304. also in beds of coal, in clays, marls and in various stones, by HENCKEL, HIAERNE, and others.

CHAP

CHAP. III.

NEUTRAL SALTS.

UNDER this name I comprehend thofe falts that have an Alkali, Earth, or Metallic Subftance for their bafis.

SPECIES I.

TARTAR VITRIOLATE.

I do not recollect that this falt has been found in the Mineral Kingdom free from all fufpicion of vegetable origin, except by Mr. BOWLES, in certain parts of SPAIN, BOWLES, p. 68. 32. Roz. Jour. 246. Its colour is greyifh white, its cryftals tranfparent, their forms various, according to the mode of its cryftalization. When its folution is fufficiently dilute and flowly evaporated, hexahædral pyramids, or fhort hexangular prifms, terminated by one or more hexangular pyramids; by fpontaneous evaporation it often gives dodecahædral cryftals, by rapid evaporation, fhapelefs maffes. It has a bitter tafte, its fpecific gravity is 2,298. BRISSON. In the temperature of 60°, it is foluble in 16 times its weight of water, but in a boiling heat requires no more than five. It does not effervefce with acids, on burning coals it decrepitates, and fcarce lofes any of its weight, but difficultly

One hundred parts of it contain 45 of real Acid, and 55 of Alkali.*

Its solution precipitates those of Barytes, Stronthian, Silver, Quicksilver, or Lead, in the Nitrous Acid, but does not disturb that of Allum; effects which sufficiently distinguish its Acid.

Neither is it affected by any Alkali, pure or aerated, but the Acid of Tartar slightly precipitates it; effects which indicate its basis. It frequently retains an excess of Acid, and hence reddens Litmus, &c.

SPECIES II.

GLAUBER's SALT.

This Salt exists in vast quantities under the surface of the earth, in various countries, particularly in the neighbourhood of ASTRACAN, where, in summer, it is found at the bottom of lakes,† and also in BOHEMIA and SWISSERLAND, where it is deposited by water, in the spring season. It is never found pure, but mixed with Natron or common Salt, or Epsom, or Selenite. It also, not unfrequently germinates from, and adheres to, the walls of recent buildings. Of that found near SEDLITZ, Mr. REUSS gives the following description.

Its colour is white, inclining to yellow; its lustre, when fresh dug, 3. its form either that of slender Crystals diverging from a common center,

* By real Acid, I mean the strongest that can exist. See the Transactions of the Royal Irish Academy, Vol. 5.

† 2 Decouvertes Russes 185.

or flatted, compreſſed and hexangular, of from half an inch to two inches long. Tranſparent or at leaſt ſemi-tranſparent, and of a cool, exceeding bitter taſte. Theſe however ſoon wither into a dull, duſty powder, its fracture, when cryſtalized is the minute Conchoidal.

By a very ſkilful analyſis he found 100 parts of this impure compound to contain 66,04 of Glauber's Salt, 31,35 of Epſom, 0,42 of Selenite, and 2,10 of Salited Magneſia.*

To the above deſcription we may add, that this ſalt effloreſces by expoſure to dry warm air, and if dried in a ſtrong ſand heat, loſes 58 per. cent. of its weight. When cryſtalized, it is ſoluble in [illegible] times its weight of water of the temperature of [illegible] or [illegible] of boiling water. It is ſubject to take up an exceſs of Acid.

One hundred parts cryſtalized Glauber contain 22 of real Acid, 17 of Alkali, and 58 of water of cryſtalization, and 3 of water of compoſition.

SPECIES III.

VITRIOLIC AMMONIAC.

This Salt is found in the neighbourhood of volcanos, tho' not ſo commonly as might be imagined,† probably becauſe its Acid, while as yet imperfect and ſulphureous, is expelled by the marine. It has alſo been found in ſome lakes

* [illegible] Chym. Ann. [illegible] 18.

† Dolomieu on [illegible]; Bergman. [illegible] Table.

in

in TUSCANY, and at the bottom of a burning well in DAUPHINE, and on the surface of the earth near TURIN.* It is generally impure, being mixed with Sulphur, Argill, Allum, or Vitriol of Iron. Hence its colour is grey, yellowish grey, or lemon yellow. It is found, stalactitic, or investing lavas, or in an earthy state, with little or no lustre, sometimes semi-transparent. Its fracture uneven. When pure, this Salt, by slow evaporation, furnishes white transparent Crystals, in the form of slender hexangular or quadrangular prisms, but if the evaporation be more rapid, only scales.

Its taste is sharp and bitterish, it slowly attracts moisture from the air; it is apt to take up an excess of Acid. In the temperature of 60° it requires twice its weight of water to dissolve it, but its own weight of water at 212°. is sufficient.

When heated, it at first slightly decrepitates, then liquefies, and in close vessels sublimes, but with some loss of its Alkali. With Nitre heated to redness it gently deflagrates.

One hundred parts crystalized Vitriolic Ammoniac contain 29,7 of mere Alkali, 55,7 of real Acid, and 14,16 of water.

Its Acid is discovered by the tests already mentioned, its basis by mixing it with Quicklime or Caustic fixed Alkalis.

* 16 Roz. Jour. p. 563. 6 Roz. Jour. p. 125, &c.

SPECIES IV.

EPSOM SALT.

The province of ANDALUSIA, in SPAIN, contains this Salt in the greatest abundance, insomuch that after heavy rains, the surface of the earth appears grey from the quantity of this Salt that germinates upon it. It is found also at the bottom of deficcated lakes, on grit stones, and Argillites.* Next to SPAIN, BOHEMIA perhaps contains most of it, it is there found in Acicular grey Crystals, or in a more compact form, mixed with reddish Clay, Selenite, and an excess of Acid; and in several Mineral Springs. Dr. ARMET found it in the GYPSUM quarries of MONTEMARTRE, near PARIS. And frequently it is seen efflorescing on Argillites. It is also contained in some Mineral Waters in most countries, particularly in that of EPSOM, and SAJDSCHUTZ in BOHEMIA. It often germinates from walls. It is often mixed with a large proportion of Glauber's Salt.

When pure, it presents quadrangular prisms, whose planes are equal, surmounted with quadrangular pyramids, or acicular Crystals. Its taste is very bitter. It effloresces by exposure to the air, it is soluble in its own weight of water at the temperature of 60° or in three fourths of its weight of boiling water. In a strong

* 32 Roz p. 247.

† Reuss in 2 Chym. Ann. 1786, 314.

ftrong fand heat it lofes half its weight by the lofs of its water of cryftalization, and foams.

One hundred parts of it contain 17 of Magnefia, 33 of ftandard Vitriolic Acid (=29, 40 real Acid) and 50 of water of cryftalization.

Its Acid is diftinguifhable by the tefts already mentioned, its earth is in fome meafure precipitable by Cauftic Volalkali, when dried and aerated, it does not harden, it is eafily foluble in dilute Vitriolic Acid, which fufficiently difcriminates it from Argill, which Volalkali can alfo precipitate, but which dilute Vitriolic Acid flowly and difficultly diffolves.

SPECIES V.

ALLUM.

It is found native in five ftates.

1ft. Invifibly difperfed thro' a marfhy black foil, unaccompanied with any other Salt, as in ARRAGON, near ALCAGNIZ. BOWLES, p. 358, and 359. Or difperfed thro' fand, and accompanied with other Vitriolic Salts, as in HUNGARY, at the bottom of fome lakes. 1 Chym. Ann. 1791. p. 528. Or 2d. in a white or brownifh white, or grey, or yellowifh grey cruftaceous form inverting lavas, in the neighbourhood of volcanos, and fome rocks in the ARCHIPELAGO, and in coal mines; or in grey flakes, or cryftaline grains, in fome Alluminous Slates, or in the form of a yellow powder, of an aftringent tafte, which blackens when expofed to flame. 5 BERGM. p. 122. Or 3d. in tender capillary filvery white Chryftals, inclining to green, of a fweetifh aftringent tafte, called Capillary Allum, HAARSALZE of the GERMANS, HALOTRICHUM, or TRICHITES of others, found

found in ITALY, SICILY, HUNGARY, &c. When contaminated with Calx of Iron, these Crystals are more or less tinged with yellow. Sometimes these Crystals are closely interwoven with each other and dentiform. Or, 4th. in soft brittle masses, that feel somewhat greasy, and thence called by the GERMANS, STONE BUTTER, of a dark yellowish colour, foliated fracture, and sweetish astringent taste. This substance contains decomposed Vitriol of Iron as well as Allum; at first it is perfectly soft, but by exposure to the air, becomes brittle. It is found in SIBERIA and SAXONY, &c. 5th. dissolved in a few Mineral Waters, as in the vicinity of HALLE in GERMANY. 1 Chym Ann. 17 8. p. 224. Mem. Paris 97. 1777. These seem to have carried it into Fossil Wood, which is often found penetrated with it. Lastly, it is found crystalized, (we are not informed how) in the caverns of SEGARIO in SARDINIA. Mem Tur. 1788, p. 160 ad fin.

Allum, when pure and properly crystalized, shoots into transparent octohædral Crystals, formed of two quadrangular pyramids, united base to base, of a sweetish astringent taste. They slightly effloresce by exposure to the air, require in the temperature of 60° to dissolve them quickly, 34 times their weight of water, but half that weight will dissolve them in some days; of boiling water they require rather less than their own weight. Exposed to a strong heat they sublime, swell, foam, and at last lose 44 per cent. of their weight. The solution always reddens Litmus, &c.

One hundred parts of Allum contain 19,78 of standard Acid (=17,62 real Acid) 18 of earth dried in a high red heat, and 44 of water of cryf-

cryſtalization, the remainder water of compoſition.

Its Acid is diſcoverable as in the foregoing Salts; its baſis by its precipitability not only by Cauſtic Volalkali, but alſo by pure Magneſia, and the difficult ſolubility of the dry precipitate in Acids.

SPECIES VI.

ALLUMINOUS ORES.

By Alluminous Ores, I mean thoſe ſubſtances in which Allum does not originally exiſt in a native ſtate, but in which it is formed by ſubſequent operations of nature, or of art. Of theſe there are three ſorts, the purely Sulphureous, the Acido-ſulphureous, and the Pyritous.

Of the purely SULPHUREOUS ORES, the moſt remarkable are, 1ſt. the *Roman*, that is, that of LA TOLFA, near ROME. It is formed in veins which run thro' rocks that ſeem of the Argillaceous Genus. The colour of this Ore is greyiſh yellow* or yellowiſh white, its luſtre 0. Fracture earthy or uneven, its hardneſs from 5 to 6.

Its ſpecific gravity about 2,424 by my tryal, See Leſke. O. 971. It has no taſte, and is inſoluble in water, does not adhere to the tongue, gives an earthy ſmell, projected on a red hot Iron it hiſſes and gives out a black ſmoke, and a ſlight ſulphureous ſmell, reddiſh Reſidum, does not effervesce with Acids. The pits out of which theſe rocks are quarried, exhibit no ſign of a vol-

* per Mazeas. 5 Scav. Etrang. p. 379.

canic

canic origin, and the Alluminous Veins run even into the APPENNINES.* Mr. MONNET found this Ore to consist of Sulphur, Clay, and a minute proportion of Iron. † Mr. BERGMAN found it to contain about 0,43 Sulphur and other Volatil Matter, 0,35 Argill, and 0,22 Silex. 3 BERGMAN. p. 271. including some minute proportion of Tartarin, and Calx of Iron.

According to DOLOMIEU, these veins are whitish, with some shades of red, and nearly as that of some Baroselenites. ‡

2d. Veins of the same sort of Ore have been discovered in certain rocks near POLINIER in BRITTANY.|| Their colour is yellowish white, feel greasy, but somewhat rough, and do not taste Alluminous.

Of the ACIDO-SULPHUREOUS ORES, the most remarkable is that of SOLFATERRA, near NAPLES, where the Allum appears in the form of a white saline earth, being formed by the action of the sulphureous Acid on Argillaceous Stones. 100 parts of this earth contain, by Mr. BERGMAN's analysis, 88 of SILEX, 4 of ARGILL, and 8 of ALLUM, but this proportion is variable. Mr. CHAPTAL's experiments have removed all doubt of the possibility of forming Allum in this maner. See also Mr. ZIMMERMAN's account in Chy. Ann. 1788, 517.

* Per [illegible] Sçav. Etrang. p. 384. and Mem. Paris, [illegible] in 8vo

† 13 Roz. Suppl. p. 3[illegible]8.

‡ Dolomieu on 3 Bergman p. 136.

|| [illegible] 5 Sçav. Etrang.

Ac

An Alluminous Subſtance of this ſort is alſo found at CAPO DI MISENO, near NAPLES; its colour is white, it is found in rounded maſſes of a ſilky luſtre, and conſiſting of delicate fibres, in which ſome few Chryſtals are interſperſed. KLAPROTH found 1000 grains of it to afford 470 grains of chryſtalized Allum, without the aſſiſtance of vegetable Alkali, and 290 more with that aſſiſtance, together with ſome ſandy green and yellow earth. 1 Klapr. 312. He alſo extracted from it 27 grains of Tartar Vitriolate.

The Ores in which Allum owes its origin to the decompoſition of PYRITES, are the moſt common, and variouſly circumſtanced.

1ſt. The PURELY PYRITOUS, as thoſe of DYLTA in the Province of NERICIA in SWEDEN, being a Sulphur Pyrites out of which, firſt Vitriol and then Allum is extracted 1 BERGMAN. p. 295.

2d. THE PYRITO BITUMINOUS, and of theſe there are three kinds, the ſtony, the earthy, and the ligneous.

Of the Stony Ore, GLANZENDER ALAUN SCHIEFER of WERNER LESKE. O. 969.

Mr. KARSTEN gives the following deſcription. * Its colour is bluiſh or dark black, yet ſometimes grey. 5. BERG. 122. It is found in extenſive ſtrata. Its luſtre 2, 3, approaching to the metallic, rarely 1, 5 BERG. 122. but in its croſs fracture 0. Its fracture ſlaty, commonly thick and curved ſlaty. 2 BERG. JOUR. 1788. p. 501.

* 3 Helvet. Magaz p. 204

[illegible], 2. feels smooth and somewhat greasy, gives a white streak.

Its hardness from 6 to 9. brittle.

The specific gravity of that of LESKE. O. [illegible] the next specimen, O. 970. is [illegible] to this species; its specific gravity exceeds [illegible].

This Ore seems to be the common Argillite penetrated with a portion of Pyrites and Bitumen.

When it contains Pyrites in such proportion as to [illegible], it is rejected as containing too much Iron, tho' it might often be worked to advantage, by adding a proportion of Clay, as Mr. [illegible] advises, or leaving the solution exposed to the air until the Iron falls.

When the proportion of Petrol is considerable, it will not effloresce by exposure to the air, and therefore must be torrefied, to burn off the Petrol and expose the Sulphur for Oxygenation, thus the Vitriolic Acid is formed, which by exposure to air and moisture slowly re-acts on the Argill, and forms Allum. In SWEDEN if 100 pounds of the Ore yield four of Allum it is worth extracting, but it generally yields much more. The mines of BECKET in NORMANDY and those of WHITBY in YORKSHIRE are mostly of this species.

According to Dr HILL, the Alluminous Ore of WHITBY is sometimes a grey Freestone, and sometimes a very hard bluish Limestone, but generally it is of the sort above described.

The Earthy Ore comprehends the softer and duller sorts, in which we may distinguish two varieties, the slaty and the compact.

FIRST

FIRST FAMILY. SLATY.

GEMEINER ALAUN SCHIEFER of WERNER, whose external appearance Mr. KARSTEN thus describes.

Its colour is greyish black, or blueish black. LESKE. O. 905.

It is found in large masses and also in small sphærical flatted masses, externally dull, internally slightly glistening, and partly dull. Its fracture plane or curved slaty, yet sometimes passing into the earthy and uneven.

Fragments, o. Trapezoidal, or plated, feels meagre, gives a dull black streak, adheres to the tongue, tastes somewhat sweetish and astringent.

Hardness from 4 to 5; frequently stains the fingers. Specific gravity 2,388 by my trial or 2,49 MUSCHENB. Borax and Microcosmic Salt, melt it with effervescence, Soda affects it but slightly, it bursts sooner or later by exposure to the air. This is the stone called BLACK SLATE celebrated among the vulgar for its medicinal properties.

It is also the same as the BITUMINOUS SHALE, already mentioned, where this Shale is sufficiently impregnated with Pyrites, as it often is in Coal Mines.

SECOND FAMILY. COMPACT.

Alaunerde erde of WERNER. LESKE. O. 952. 954.

Its colour greyish or brownish black

Found forming intire strata. Lustre, o. 1. from a few dispersed shining particles. Transparency,

parency, 0. Fracture, earthy or uneven, tending to the Conchoidal, yet often inclining to flaty, at leaft in the grofs. Fragments, 2.

Hardnefs from 4 to 5, commonly friable. Specific Gravity 1,7503.

Has a fharp tafte, does not adhere to the tongue, gives a black ftreak of fome luftre.

Placed amidft burning coals, it commonly gives fome flame.

When moiftened and expofed to the air, and in fufficient quantity, it foon heats, and fometimes inflames.

The black flaty clay found near FREYENWALDE, belongs alfo to this fpecies, it is penetrated with Petrol, contains alfo Magnefia, and fome traces of Glauber's Salt. 2 Chym. Ann. 1785. p. 48.

One hundred parts of it after torrefaction, afforded Mr. KLAPROTH 10 of Allum, 7,25 of Vitriol, 2,25 of Selenite, and 1 of Epfom Salt. 1 Chym. Ann. 1785. p. 478.

Turf has alfo been found fo impregnated with Pyrites as to yield Allum. Per SWAB. SWED. ABHANDL. 1767. 92.

The LIGNEOUS ORE, confifts of foffil wood penetrated with Petrol and Pyrites from which Allum is extracted in HESSE and near MUNDEN. VOGEL. p. 322.

SPECIES VII.

VITRIOL OF IRON.

This Salt is frequently found native in grottos, caverns, and galleries of mines, either in the form of pale green Cryftals, or more generally of a grey,

a grey, or yellowiſh, or reddiſh grey efflorefcence, or ſtalactitic, or capillary; but ſcarce ever pure, being mixed either with Copper, Zinc, or Allum.

It is alſo ſometimes contained in mineral waters that are not ſulphureous.

When pure, it crystalizes in green Cryſtals in the form of rhomboidal parallelipipeds. Of a ſharp aſtringent taſte. Theſe effloreſce by expoſure to the air, and become yellowiſh mixed with red.

It is ſoluble in ſix times its weight of water in the temperature of 60° but of boiling water it requires no more than its weight. Its ſolution, if expoſed to the air, ſoon grows turbid.

Heated, it at firſt becomes yellow, and in a ſtrong heat, red, and loſes about 40 per cent of its weight, and in a ſtill ſtronger, gives out its acid, leaving a reddiſh reſiduum.

One hundred parts of it contain 28 of Calx of Iron nearly, =22 of Metallic Iron, 26 of real Acid, 38 of Water of Cryſtalization, the remainder Water of Compoſition.

Its ſolution is blackened by vegetable aſtringents, and precipitated blue by the PRUSIAN ALKALI.

Its Acid is diſtinguiſhed by the uniform undiſturbed mixture of its ſolution with the ſolutions of other Vitriolic Salts, while it precipitates the nitrous ſolutions of Calx, or Lead, or Barytes, &c and its baſis by its blackening with vegetable aſtringents, precipitating by boiling, or expoſure to the air.

Vitriol is extracted from Martial Pyrites either ſpontaneouſly effloreſcing or undergoing this change after torrefaction. Good Pyrites properly treated yield about two-thirds of their weight of Vitriol.

It

It is also procured from water impregnated with Copper, and deprived of the Copper by Iron which replaces it. The Vitriol thus prepared always retains some Copper. In HUNGARY it is obtained from pyritous shistus, and in many places from ores of Calamine. The Vitriol of GOSLAAR contains a portion of Zinc as that of HUNGARY [illegible] SAXONY [illegible] Copper. The English [illegible] Vitriol, [illegible] Vitriol with Alum. [illegible]

SPECIES VIII.

VITRIOL OF COPPER.

This Vitriol has been found native and crystalized tho' very rarely, in AUSTRIA, TRANSYLVANIA, and SIBERIA.* And also stalactitic; its colour is blue more or less verging on green; more commonly dissolved in waters. It is always contaminated with Vitriol of Iron or Zinc, and often with both, in HUNGARY, BOHEMIA, FRANCE, SICILY and IRELAND.

When pure, the colour of these Crystals is deep blue. Their form that of oblong rhomboids. Soluble in about 4 times their weight of water in the temperature of 60°. By exposure to the air, they slightly effloresce, lose their lustre, and are covered with a yellowish grey powder; they communicate a green colour to flame.

* 1 Bern Phy. Arb. 1 Stuck.

One

One hundred parts of Vitriol of Copper, contain nearly 35 Calx of Copper, equal 26 in its metalic ſtate, 27,68 of real Acid, and 28 of water of chryſtalization, the remainder water of compoſition. Theſe proportions, however, I have not yet aſcertained by my own Experiments.

The ſolution of this Vitriol depoſits Copper on a clean poliſhed piece of Iron, and with Volalkali aſſumes an Indigo blue colour. This detects its baſis. Its Acid is known by the undiſturbed mixture of the ſolution with thoſe of other Vitriolic Salts.

Ninety two parts metallic Iron are ſufficient to precipitate 100 parts of Copper in its metallic ſtate when the ſolution contains no unuſual exceſs of Acid.

This Salt is generally obtained from the waters that naturally contain it, and occaſionally from Sulphurated Copper Ores after torrefaction. Schlutt. 638. It is ſeldom free from Iron, and ſometimes it contains Zinc.

SPECIES IX.

VITRIOL OF ZINC.

It ſeldom occurs native in its perfect ſtate, generally ſtalactitic, capillary, or in the ſtate of efflorеſcence in a looſe powder. The colour always grey, or white, or reddiſh white, rarely ſomewhat indurated.

When pure its colour is white, its form that of rhomboidal priſms ſurmounted with quadrangular pyramids, of a ſharp ſtyptic taſte, theſe ſlowly effloreſce by expoſure to the air. They

are

are ſoluble in about twice their weight of water at the temperature of 60°. When heated they loſe above 30 per cent of their weight.

One hundred parts of Vitriol of Zinc thus cryſtalized, contain 20 Calx of Zinc. 26,4 of Metallic Zinc, 12 of real Acid, and 40 of water of cryſtallization, the remainder water of compoſition, theſe proportions I have as yet determined only by analogy.* But the white Vitriol of the ſhops contains a large proportion of Iron. And the native almoſt always both Iron and Copper.

Treated on Charcoal by a blow-pipe it effervеſces, but does not phoſphoreſce as flowers of Zinc do, like them it unites to Microcoſmic Salt and Borax with effervеſcence, but ſo it does to Alkali too, which they do not. 2 BERGMAN. p. 319.

SPECIES X.

MIXED VITRIOL OF IRON, COPPER AND ZINC.

This is frequently found in the galleries of mines in SWEDEN, SAXONY and the HARTZ. Mr. KARSTEN deſcribes it thus.

Its colours are greyiſh, or yellowiſh white, apple green, pale verdigris green, and azure blue. Either in amorphous maſſes, or interſperſted, or Stalactitic. Its external luſtre caſual. The internal 2. Silky.

* Mr. Bergman allows to 100 parts of Vitriol of Zinc, 20 of Zinc, and 40 of Acid, but there muſt be ſome miſtake, for by 3 Bergm. p. 149. We find that 38 parts Zinc, take up the Acid of 100 parts of Vitriol of Copper, which he fixes at 46 grains. Now if 38 take up 46. 20 ſhould take but 24, 2.

Its

Its ſurface moſtly rough and uneven. Tranſparency 2. 3. Its fracture delicately ſtreight, fibrous, and where brighteſt, foliated. Its fragments 1. Its taſte auſtere and ſtyptic.

To ſeparate theſe, let the Iron be oxygenated by boiling and expoſure to the atmoſphere, the Calx of Iron being ſeparated, precipitate the Copper by adding more Iron, and ſeparate this by oxygenation, as before; then the Zinc alone will remain ſeparable by Alkalis. Or ſeparate the Copper by a bar of Iron previouſly weighed, and then the Iron by Zinc, noting alſo its weight, from the precipitate of Iron ſubtract the weight loſt by the bar, the remainder is the weight contained in the ſolution; ſo alſo from the precipitate of Zinc, ſubtract the weight loſt by the piece inſerted. The table will ſhew the correſpondence of theſe weights with the Metals in their perfect ſtate. The Copper may alſo be precipitated by Zinc.

SPECIES XI.

NITRE.

Putrefaction of vegetables, and particularly of animal ſubſtances, was until lately thought neceſſary for the production of this Salt; but at preſent it ſeems clear, that nothing more than a Calcareous Matrix heat, and an open, but not too free a communication with dry atmoſpheric air, is requiſite. With theſe circumſtances it has been found native in various countries in warm climates. In India, Spain, and as ſome ſay in Persia and China, it germinates in certain ſeaſons out of the earth, and what is more ſingular, this earth accumulated in large heaps, and thus

exposing a larger surface to the atmosphere, is found to re-produce it annually.* In PERU it has been found in tracts where it never rains. In FRANCE the DUKE of ROCHEFOCHAUT discovered it in Calcareous Caverns.† and Mr. PICKEL, in GERMANY, also on the surface of Calcareous Cavities communicating with, but not exposed to the open air;‡ as did Mr. RUCKERT in certain sandy tracts in HUNGARY untrodden by any animals; and dissolved in such quantity, in springs, that he was led to imagine that vast strata of it must exist in the interior parts of the earth.|| But the most celebrated discovery of native Nitre was that made by ABBE FORTIS, in APULIA, in the PULO or cavity of MOLFETTA. In this hollow, which is about one hundred feet deep, there are several natural grottos, in the interior part of which, between strata of compact Limestone, Nitre is found irregularly crystalized. The stone itself is so richly impregnated with it, that it bursts it in many places, and forms white efflorescences and crusts resembling Canary Sugar, mixed with Gypsum on its surface; when these efflorescences are scraped off, more is generated in the space of about a month, but more quickly in summer than in winter. It is more plentifully found in those grottos whose appertures face to the N. W. towards the sea, which is some miles distant. This Nitre is accompanied with a small

* Bowles p. 72, 77, 78, 79. 32 Roz. Jour. p. 256.

† 1[illegible] Roz. Jour. 283. 2 Townsend's Spain, 211.

‡ Chy. Ann. 1791. p. 323.

|| Chym. Ann. 1793. p. 224.

pro-

proportion of Muriated Tartarin, and it should seem as if masses of some Salt of this kind existed at a greater depth, for a well dug in the middle of the PULO abounds in Salt after heavy rains. Nitre has afterwards been discovered in several other cavities, as at GRAVINA, ALTAMURA, &c. In some of which animals were stabled, but these contained least. See Professor ZIMMERMAN's accurate account in 36 Roz. Jour. p. 109. Nitre is sometimes found in the wells of great cities, as at LONDON, BERLIN, &c. Tho' in the common processes it is extracted from old mortar, yet Mr. LAVOISIER has shewn that it is rather a product of the operations employed, as the Nitrous Acid in mortar is for the most part united to Calcareous Earth, and the Nitre formed from the Vitriolated Tartarin contained in the ashes, by a double decomposition*.

Nitre shoots into slender oblong hexagonal Prisms, surmounted with hexagonal pyramids obliquely truncated, the native is generally acicular or woolly. Its taste sharp and cooling. It does not effloresce or deliquesce. It is soluble in seven times its weight of water, of the temperature of 60°, and in somewhat more than its own weight of boiling water. On a red hot Iron or burning coals, it hisses and detonates; the natural is generally accompanied with common Salt.

It consists of about 41,2 parts of real Acid, and 46,15 Tartarin The remainder Water of Composition, accompanying the Acid, and hitherto confounded with it, both by myself and others.

* Mem. Paris. 1777.

SPECIES XII.

NITRATED SODA.

This Salt is very rarely found native; however, Mr. BOWLES ascribes it to SPAIN, and Mr. NAUWERKE of DRESDEN, found it in Lanuginous Crystals on the walls of an old cellar. 2 Chym. Ann. 1784. p. 313.

This Salt crystallizes in Rhomboidal Crystals, requires about three times its weight of water to dissolve it, at the temperature of 60°, has a cooling bitterish sharp taste, and slightly attracts moisture from the atmosphere. It deflagrates as the former; both in a strong heat become alcalescent; both give out a nitrous smell, and fume by the addition of concentrated Vitriolic Acid. Tartarin decomposes this Salt, and the solution by evaporation affords Prismatic Nitre; both give an Aqua Regia when dissolved in Spirit of Salt.

One hundred parts of this Salt contain 42,35 of Alkali, and 57,65 of real Acid.

SPECIES XIII.

NITROUS AMMONIAC.

This Salt is seldom found except in artificial beds of Nitre.

It difficultly shoots into regular acicular Crystals somewhat flexible, and quickly deliquesces.

It inflames when heated to redness. 100 Parts of it contain about 26 of Alkali, 58 of real Acid, the remainder Water, mostly of Composition.

As

As when diſſolved in Spirit of Salt, it forms Aqua Regia, its Acid is eaſily diſcovered ; and Quicklime, or fixed Alkalis, detect its baſis.

SPECIES XIV.

NITRATED CALX, OR NITROUS SELENITE.

Wherever Native Nitre is found, this Salt is alſo found, and much more plentifully ; and frequently without it, either embodied in Calcareous Stones, or adhering to them in a cruſtaceous ſtate. Alſo diſſolved in ſeveral ſprings.*

When properly managed, it forms Acicular Cryſtals readily deliqueſcent. Its taſte is ſharp and bitteriſh. It gives out its Acid in a red heat.

100 Parts of lime take up 180 of real Nitrous Acid.

Tartarin decompoſes it, and forms Priſmatic Nitre, which evidences its Acid. Cauſtic Volalkalis do not alter it, but Vitriolic Salts form a precipitation in its ſolution, which, with the difficulty of cryſtallizing it, determines its baſis.

SPECIES XV.

NITRATED MAGNESIA, OR NITROUS EPSOM.

It has been found native in the Mother Liquor of Nitre, and alſo aſſociated with Native Nitre,

* Sprat's Hiſtory of the Royal Society, p. 264. and 4 Crell's Beytr. p. 18.

and

and in ſome ſprings.* A ſaturate ſolution of this Salt ſlightly evaporated yields, after a long time, quadrangular Priſmatic Cryſtals, of a ſharp and very bitter taſte, eaſily deliqueſcent, and which give out their Acid in a red heat.

100 Parts Magneſia take up 255 of real Nitrous Acid.

Precipitated by Tartarin, it affords Priſmatic Nitre, and with concentrated Vitriolic Acid, it gives out the Nitrous Acid, which evidences its Acid. Mild Magneſia does not diſturb its ſolution, which ſufficiently indicates its baſis.

SPECIES XVI.

MURIATED TARTARIN.

SALT OF SYLVIUS.

Meſſrs. Bowles and Proust inform us, that this Salt accompanies the Native Nitre found in the environs of Madrid. † Mr. Monnet alſo found it in ſome Mineral Waters in Normandy. Hydrol. 263.

When pure, this Salt forms Cubic Cryſtals, it is ſoluble in three times its weight of water of the temperature of 60°, or in twice its weight of boiling water. It decrepitates when heated, but does not give out its Acid.

100 Parts of it contain about 46 of Alkali, and 36 of Real Marine Acid.

It forms Aqua Regia when diſſolved in Spirit of Nitre, and forms a cloud in the nitrated ſolution of Silver; Concentrated Vitriolic Acid ex-

* 32 Roz. Journ. p. 246.

† 11 Scav. Etrang. Hiſt. 101.

pells

pells its Acid, circumſtances which evince its Acid. Alkalis do not diſturb its ſaturate ſolution, but Acid of Tartar quickly forms a precipitate in it; appearances which detect its baſis.

SPECIES XVII.

COMMON SALT. SAL GEM.

Beſides the immenſe quantity of this Salt diſſolved in the Ocean, it is found in vaſt maſſes *under* the earth's ſurface, in many countries, particularly in POLAND and HUNGARY, *on its* ſurface in ſandy deſarts, near ASTRACAN, &c. and *over* the earth's ſurface, in SPAIN, near CARDOVA, 16 leagues from BARCELONIA, where it forms a mountain 500 feet high, and three miles in circumference; tho' Gypſum does not accompany it, as it uſually does in other places *. In ENGLAND, and moſt other European countries, it is found in leſs conſiderable ſtrata, and chiefly diſſolved in water, often mixed with Gypſum, Muriated Magneſia, or Calx, or Pyrites, or embodied in various ſtones; or cruſtaceous, near volcanos. Of this Salt Mr. WERNER diſtinguiſhes two varieties, which Mr. KARSTEN deſcribes nearly as follows †:

* 4 Helvet. Magaz. 436.

† Bowles; and Townſend's Travels into Spain. vol. 1. p. 122. Iriſh Edition.

FIRST

FIRST VARIETY.

LAMELLAR.

Its colour is grey, yellow, reddiſh, or pearl grey; or hyacinth, fleſh, or browniſh RED, found in vaſt maſſes with conic impreſſions, alſo cryſtallized in cubes. External luſtre caſual, Internal, 2. 3. Glaſſy. Tranſparency, 2, 3, 4. The ſurface of the Cryſtals ſmooth, when the lamellæ are intire. Fracture foliated. Fragments cubic, gives a grey ſtreak, its taſte is well known. Hardneſs commonly from 4 to 5, ſometimes 8. Specific gravity, 2,143. BRISSON.

SECOND VARIETY.

FIBROUS.

Its colour partly greyiſh white, partly yellowiſh grey, pearl grey, lavender blue, or fleſh red, found in amorphous maſſes, in ſtrata, or ſtalactitic. Luſtre, 2. Tranſparency, 3, 4.

Fracture delicate curved fibrous, rarely ſtraight or diverging.

Fragments angular. Hardneſs, 5.

Common Salt cryſtallized by art aſſumes various forms according to the mode of cryſtallization, and the purity of the water in which it is diſſolved. Sometimes it preſents cubes, ſometimes quadrangular octagons like Allum, and ſometimes quadrangular pyramids, &c

It is ſoluble in ſomewhat leſs than three times its weight of water, at the temperature of 60°. and requires

requires little lefs even at the heat of ebullition. It neither deliquefces nor effloreſces. But it uſually contains Marine Epſom which renders it deliqueſcent, heated it decrepitates, loſing the water ſoaked by its Cryſtals. It does not give out its Acid in any heat, but rather volatilizes.

One hundred parts of common Salt contain 35 of Alkali, and nearly 40 of real Marine Acid, the remainder moſtly Water of Compoſition; its component parts are diſtinguiſhable as thoſe of the foregoing, its ſolution is not diſturbed by the affuſion of the Acid of Tartar, which diſtinguiſhes its baſis from that of the laſt mentioned.

One hundred parts of pure common Salt precipitate from the Nitrous ſolution of Silver. 235 parts of Luna Cornua well dried.

SPECIES XVIII.

SAL AMMONIAC.

Not only the neighbourhood of Volcanos and Pſeudo-volcanos preſent this Salt, but alſo the interior parts of ASIA and AFRICA, where no ſuch eruptions have taken place. Thus Mr. ZIMMERMAN has noticed it at SOLFATERRA.* Mr. MORAND, near French Pſeudo-volcanos.† Various travellers, in TARTARY and THIBET. As alſo in the Mineral lakes of TUSCANY.‡

* Chym. Ann. 1788. p. 518.

† Mem. Paris 1761. p. 21[illegible]

‡ 16 Roz. Jour. p. 362.

Its colour yellowish grey, or smutty apple green, or brownish black, from a mixture with Iron.

Its form that of compact lumps, seldom large, most commonly lanigunous Crystals, or interwoven.

Its lustre 1. 2. glassy. Hardness from 3 to 4. Its taste sharp, cool and saltish*.

It wholly evaporates when laid on a hot Iron.

When pure, it requires about three times its weight of water to dissolve it, at the temperature of 60°, and much less at 212°. It commonly slowly deliquesces, when crystalized, its Crystals are plumose.

One hundred parts Sal Ammoniac contain about 30 of Alkali, 35 of real Acid, the remainder, Water partly of Crystallization, and partly of Composition.

Its Acid is distinguished by forming Aqua Regia, when this Salt is mixed with pure Nitrous Acid; and its basis, by evolving the Alkaline smell, when mixed with quick lime.

SPECIES XIX.

MURIATED BARYTES.

This is said to be found in some Mineral Waters in SWEDEN. BERGM. SCIAGR. §. 58.

It easily crystallizes, its solution decomposes the nitrated solution of Silver, and with mild Soda affords common Salt, characters sufficient to distinguish it; Vitriolic Acid forms with it an insoluble precipitate, it is not precipitable by Stronthian or Barytic lime water, circumstances which, with its crystallization, sufficiently indicate its basis.

* Helv. Magaz. p. 137.

SPECIES

SPECIES. XX.

MURIATED CALX.

Salt ſprings commonly abound with this Salt. It alſo occurs in other Mineral Waters. It is always deliqueſcent, difficultly cryſtallizes. Its taſte bitter. Its Acid is detected as in the foregoing caſes. Its baſis, by its precipitability by Vitriolic Acid, and Acid of Sugar. It retains its Acid in a ſtrong heat.

One hundred parts of it dried in a ſtrong heat contain about 53,5 of Calx, and 46,5 of real Marine Acid. Or 100 parts Lime take up 86 of real Marine Acid.

SPECIES XXI.

MURIATED MAGNESIA. MARINE EPSOM.

This is alſo chiefly found in Salt and other Mineral Springs, and abounds in the ſea. It cryſtallizes by particular management, but generally deliqueſces. Its taſte is very bitter. It quits its Acid for the moſt part in a ſtrong heat. Its ſolution is precipitated by Cauſtic Volalkalis, and not viſibly by the Vitriolic Acid; reſults which diſtinguiſh its baſis from all other earths, except Argill. If precipitated by a mild Alkali and dried, it is eaſily ſoluble in Vitriolic Acid, which diſcriminates it readily from Argill.

SPECIES XXII.

MURIATED ARGILL.

Dr. WITHERING informs us he has diſcovered this Salt in great plenty in NEVIL HOLT WATER and ſuſpects it to exiſt in that of BALYCASTLE.* It is deliqueſcent, hath an aſtringent taſte, difficultly cryſtallizes, and, when much evaporated, forms a gummy maſs, but in a ſtronger heat gives out its Acid. Its ſolution is precipitable by mild Magneſia and alſo by unaerated Calx. The precipitate heated and dried, is difficultly ſoluble in Acids, characters which ſufficiently diſtinguiſh it.

SPECIES XXIII.

MURIATED IRON.

It is found in the neighbourhood of volcanos. DOLOM. on 3 BERGMAN, p. 96.

This Salt is deliqueſcent, and ſoluble in Spirit of Wine.

SPECIES XXIV.

MURIATED COPPER.

This is alſo found near volcanos, DOLOM. on 3 BERGMAN, p. 96.

* Sciagr. p. 31.

SPECIES

SPECIES XXV.

MURIATED MANGANESE.

Mr. HIELM is the only perſon who has as yet obſerved this Salt in nature, he diſcovered it in one of the lakes of SWEDEN. It is precipitated of a whitiſh yellowiſh colour by the Pruſſian Alkali, and of a browniſh yellow by Soda. It does not cryſtallize in any diſtinct form but is deliqueſcent, and ſoluble in Spirit of Wine, which Vitriol of Manganeſe is not.

Note—Other Metallic Salts being found chiefly in Mines and uſed as Ores, will be treated of in the 4th part.

SPECIES XXVI.

BORAX, TINCAL.

THIBET and PERSIA are the only countries now known to poſſeſs this Salt. The accounts of its exiſtence in PERU not being yet confirmed. It ſeems to exiſt in ſome lands adjacent to lakes, from which it is extracted by water and depoſited in thoſe lakes; whence, in Summer, when the water is ſhallow, it is extracted and carried off in large lumps. Sometimes the water in theſe lakes, is admitted into reſervoirs, at the bottom of which when the water is exhaled by the Summer's heat, this Salt is found. Hence it is carried to the EAST INDIES, where it is in ſome meaſure purified and cryſtallized, in this ſtate it comes to EUROPE and is called Tincal. In other parts of THIBET, it ſeems, by accounts received from

from CHINA, they dig it out of the ground at the depth of about two yards, where they find it in small cryſtalline maſſes, called by the Chineſe *Mi Poun*, *Hou Poun*, and *Pin Poun*, and the Earth, or Ore is called *Pounxa*.

Their colour greyiſh white, ſurface withered, as if effloreſcing, their form partly that of quadrangular priſms ſurmounted with pyramids, ſome hexangular or octangular, moſtly irregular, ſome ſemi-tranſparent.

The earth is nothing more than a grey Marl mixed with this Salt *.

In PERSIA it exiſts in certain wells, whoſe waters are conducted into reſervoirs, and after evaporation, depoſit the Borax or Borech, as they call it †. This they cryſtallize and ſend to us often ſophiſticated by an addition of Soda, and covered with greaſe, probably to prevent its effloreſcence; theſe are of a dull white or greeniſh colour.

Borax, when pure, ſhoots (by ſlow cooling and inſenſible evaporation) into hexangular Cryſtals, of which two ſides are much broader than the remainder, and thence flat, with triangular pyramidal ſummits, of a ſomewhat Alkaline taſte, and which do not effervesce with Acids, or but ſlightly, yet turn Syrup of Violets green.

This Salt is ſoluble in eighteen times its weight of water, at the temperature of 60°, but of boiling water it requires but ſix parts. It ſlowly and ſlightly withers, by expoſure to the air. Heated, it ſwells and loſes about four

* Swed. Abhandl. 1772. p. 317.

† Philoſ. Tranſ. 1787. p. 298. and 1789. p. 96. 2 Mem. Scav. Etrang. p. 418. 30 Roz. Jour. p. 393.

tenths

tenths of its weight, becomes ropy, forms a calcined mafs, like burned Allum, and at laft paffes into a tranfparent glafs, which however is foluble, as before.

If Borax be diffolved in warm water, and concentrated Vitriolic Acid dropped into the folution, until it taftes Acid, and the folution evaporated until white particles appear on the furface, and then fuffered to cool, light filvery flakes will be found, which feparated by filtration and wafhed, exhibit the Boracic Acid, foluble in Spirit of Wine, to whofe flame it communicates a green colour. The Refiduum furnifhes Glauber's Salt, and thus the conftituent parts of Borax are evidenced.

100 Parts Borax contain, according to BERGMAN, 17 Soda, 34 Boracic Acid, and 49 of Water.* But this Soda is ftill unfaturated, and according to Dr. WITHERING Borax requires twice its weight of Boracic Acid to faturate it. SCIAGR. p. 26.

Note—Mr. LAUMON difcovered a fingular Acid Subftance, united to Iron, forming a foluble fubftance and therefore a Salt, in the Mine of HUELGOAT, in BRITTANY. 28 Roz. Jour. p. 385. which fee.

* Scheff. Vorles. p. 147.

PART

PART III.

OF

INFLAMMABLE SUBSTANCES.

BY INFLAMMABLE SUBSTANCES I underſtand all thoſe of Mineral Origin whoſe *principal* character is Inflammability. A criterion which excludes Diamonds and Metallic Subſtances, tho' alſo ſuſceptible of combuſtion.

Of theſe the ſimpleſt kinds may be reduced to ſix Genera, namely the AERIFORM, the BITUMINOUS, CARBONACEOUS, VEGETO-CARBONACEOUS, VEGETO-BITUMINOUS, and the SULPHUREOUS. Of theſe, or ſome of them, mixed with other ſubſtances, that are not eſſential to Inflammability, all the natural Inflammable Subſtances of Mineral Origin ſeem compoſed. All are inſoluble, at leaſt in their totality, in Spirit of Wine, as well as in Water and Acids, but generally yield to ſome ſpecies of Oil or Æther. Their ſpecific gravity is below or ſcarcely exceeds 2,00 unleſs loaded with foreign matter.

1ſt GENUS.

1ſt. GENUS.

The general character of this Genus, is Inflammability, with a Phoſphoric ſmell, beſides its aeri-form ſtate.

INFLAMMABLE AIR.

Of this there are two Species, the Light and the Heavy.

LIGHT Inflammable Air is from 10 to 14 times lighter than Atmoſpheric Air, and explodes all at once when mixed with two or three times its weight of Common Air.

2d. HEAVY Inflammable Air differs from the former, only in holding Coaly matter in ſolution, and hence it requires a greater proportion of reſpirable air to conſume it. It is often alſo contaminated with fixed air, and oily matter. Its weight is from twice to eight times leſs than that of an equal bulk of common air. It burns with a blue lambent flame.

Both theſe are found frequently in mines, and particularly in Coal mines. The latter has been obſerved in moraſſes, that obſerved on the ſurface of ſprings in PERSIA, ITALY and FRANCE, is frequently nothing more than the vapour of Petrol.

There is alſo a third Aeriform Inflammable Subſtance, called Hepatic Air, of which I ſhall treat under the article Sulphur.

2d. GENUS.

The BITUMINOUS.

SPECIES I.

NAPHTHA.

Its colour is white, or yellowish white; its fluidity and transparency as those of water, its smell penetrating but not disagreeable; feels greasy, catches fire on the approach of flame. It burns with a light flame leaving scarce any residuum. Its Specific Gravity is ,703 Musch. When pure, per Boulduc, it is one seventh lighter than Rectified Spirit of Wine (whose Specific Gravity cannot be more than ,850,) then its Specific Gravity should be 0,729, which I believe is nearer the truth. When yellowish, and consequently less pure, its Specific Gravity per Brisson is 0,8475. It is insoluble in Spirit of Wine, passes intirely in distillation, is thickened, but not inflamed, by the concentrated Nitrous Acid, and does not congeal at 0° of Fahren.

These observations were made on Naphtha found at Mont Festin near Modena. Hist. Acad. Par. 1715, and near Miano in the Dutchy Parma. Mem. Paris 1770. It is also found issuing from Rocks or Clays in Persia, and also, as is said, in Sicily.

SPECIES

SPECIES II.

PETROL. Erdol of Werner.

Its colours are pale, or reddiſh yellow, or greeniſh yellow,* or reddiſh brown, or reddiſh black. Its tranſparency from 2, to 3, ſometimes 1. Its ſmell like that of the former ſpecies, but leſs agreeable Its fluidity leſſer, as alſo its inflammability. Its Specific Gravity per Brisson, 0,8783.

Petrol is evidently nothing elſe but Naphtha, altered by the action of the air, which oils imbibe, as Dr. Priestley in the 3 vol. of his obſervations, and lately Mr. Senebier, 11 Ann. Chym. p. 89. have ſhewn.

Reſpirable Air unites partly to the Inflammable Air which it conſumes (that is, converts into water) and partly to the carbonic principle which it converts into fixed air, and this, combining with a further proportion of Inflammable Air, Carbon and Water, form an Acid, and thus the oil is thickened, and more inclined to yield to Spirit of Wine to which it then gives a ſlight tinge. When burned, it, affords a ſoot and leaves a ſmall quantity of a Coaly reſiduum.

It is found in the ſame Countries as the former, and alſo in the ſouth of France, Hungary, Poland, Germany, Swisserland, Scotland, &c. frequently covering water, to whoſe ſurface it gives the colours of the rainbow, and hence frequently obſerved on the water of ſome bogs.

It is alſo contained in minute quantities in vari-

* 1 Chym. Ann. 1785. p. 85.

ous ſtones as we have already ſeen, but ſometimes its quantity is remarkable great, as in the Black Limeſtones of SEEFIELD in TYROLE. Their fracture is conchoidal. Luſtre 2, Specific Gravity inconſiderable. They yield by diſtillation *per deſcenſum* from 40 to 50 per cent of this oil. 1 Chym. Ann. 1785. p. 370. And alſo in BITUMINOUS SHALE, or mixed with earths which are generally BLACK, but ſometimes WHITE, as the kind of Guhr found by Mr. MORVEAU. Digreſs. Acad. p. 378.

SPECIES III.

MINERAL TAR, BARBADOES TAR.

BERGTHEER OF THE GERMANS.

This is a Petrol ſtill farther altered by expoſure to the air.

Its colour is black, or browniſh black, or browniſh red, it is glutinous and nearly of the conſiſtence of Pitch.

Its ſmell, ſometimes ſtrong and diſagreeable; ſometimes, ſcarcely odorous or merely faint. Its ſpecific gravity, 1, 1. Expoſed to the air it becomes more viſcid, yet if we believe LEHMAN, it becomes lighter.

It is found in many parts of ASIA, AMERICA, and EUROPE particularly at LAMPERSLOCK, near STRASBURGH mixed with ſand, from which it is detached by heating it in water. Mem. Berl. 1785. in IX. Coll. Acad. p. 407.

SPECIES

SPECIES IV.

MINERAL PITCH, ASPHALTUM.

ERDE PECH OF WERNER.

Mineral Tar expofed to a moderate heat, and the action of the air, hardens into this fubftance There are however fome fhades of variety of confiftence, and hence Mr. WERNER diftinguifhes three Varieties of it.

FIRST VARIETY.

COHÆSIVE MINERAL PITCH.

ZAHES ERDE PECH OF WERNER.

Its colour is black or dark brown. Luftre, 0, Its fracture, uneven, tough.

Its fpecific gravity from 1,45 to 2,06 but fome uncertainty attends this determination, as water fcarcely applies to it, feels fomewhat greafy and yields to compreffion, has a heavy fmell, acquires a polifh when fcraped, does not adhere to the tongue; does not ftain the fingers, on a white hot Iron, it flames with a ftrong fmell, leaves no coal but only grey afhes, and to the quantity of this I attribute the high Specific Gravity of the fpecimen I tried.

SECOND

[illegible]

[illegible]

[illegible] OF WERNER.

[illegible] Fracture [illegible]

[illegible] Gives [illegible] as the former, [illegible] denote it [illegible] found in [illegible] Specific Gravity; [illegible] contains only 14 [illegible] Bitumen, the remainder being [illegible]

THIRD VARIETY.
COMPACT.

[illegible] ERDPECH OF WERNER.

ASPHALT.

Its colour [illegible], or greyish black. Lustre, 2, [illegible] Fracture perfectly conchoidal. [illegible] from 7 to 8, very brittle. Specific Gravity from [illegible] to [illegible], by my trial. [illegible] Has no smell; [illegible] When heated it melts, [illegible] but requires an [illegible]

It is found in different parts of EUROPE and ASIA, but perhaps in greatest plenty in the Isle of TRINIDAD. Philo. Transf. 17 9, p. 05.

It appears that Bitumens leave scarce any Residuum, the earthy part being merely accidental, and that the Carbonic Substance is by much the smallest in their composition, as their concretion seems wholly owing to the absorption of air, and not to the prevalence of the Carbonaceous principle, since no Coal appears, when they are burned on a hot Iron.

SPECIES V.

MINERAL TALLOW. BERGFET.

This is a substance very rarely met with, and therefore very imperfectly known; It was first found by some Peasants on the Coast of FINLAND in the year 1736. Afterwards a similar substance occurred in one of the Swedish Lakes, and lastly, Mr. HERMAN, a Physician, at STRASBURGH, discovered a similar substance in the water of a Fountain near that City.*

Its colour is white, its consistence that of Tallow, it feels greasy and stains paper just as Tallow does, the traces thus left on paper melt on the approach of flame. Its flame is blue accompanied with much smoke, and leaves a coaly matter. It is brittle like Tallow. Its Specific Gravity is 0,770. whereas, that of Tallow is from 0,94 to 096.

It is imperfectly soluble in highly Rectified and Tartarized Spirit of Wine, in the heat of ebullition, and is deposited on cooling, but is said to yield to oil of Almonds.

* 1 Mem. of Swed. p. 87. and 3 Roz. Jour. p. 346.

SPECIES VI.

MINERAL CAHOUTCHOU.

This is found near CASTLETOWN in DERBYSHIRE, mixed with Galena and Calcareous Spar, and is thus defcribed by Mr. DE LA METHERIE the prefent Editor of the Journal De Phyfique, formerly publifhed by ROZIER.* Its colour is brown, or deep brown; partly foft flexible and elaftic, and this when cut, is internally of a greenifh yellow colour, partly hard and brittle, the fracture of this part is conchoidal, both forts are often united in the fame fpecimen

Both are infoluble in Spirit of Wine, and Æther, and Oil of Turpentine, but yield to that of Olives; Nitrous Acid does not affect them. Diftilled, they yield an Oil, infoluble in Spirit of Wine; but no Volalkali. The refiduum feems Carbonaceous.

* 31 Roz. Jour. p. 312. For Brevity I ftill quote it Roz. Jour.

3d GENUS

3d GENUS.

CARBONACEOUS SUBSTANCES.

The general Characters of this Genus are Inflexibility and infusibility.

SPECIES. I.

NATIVE MINERAL CARBON.

Blende Kohle of Werner.

This is a substance agreeing in all its Chymical properties with Charcoal, possessing at the same time most of the external characters of Pit coal, and seems to me to be the natural Carbonic principle, as pure as nature generally affords any principle.

Its colour is black,* or greyish black. Its Lustre from 3 to 4, approaching to the Metallic.

Transparency 0. Fracture foliated or slaty, its cross fracture flat conchoidal.

Its fragments tabular. Hardness from 4 to 5, brittle. Specific Gravity from 1,4 to 1,53. Stains the fingers.

This description is taken from the purest specimens that have as yet occured, namely, that found near STRIDO in the Territory of FLORENCE. 2 CHYM. ANN. 1793. p. 402 and 404, and that found at LISCHWISZ near GERA, in extensive strata described by Mr. HOFFMAN†, and analysed by Mr. WIEGLEB. 2 Chym. Ann. 1790. p. 30. and that mentioned by Mr. WIDEMAN, 1 BERGM. Jour. 1789. p. 609. analysed by Mr. KLAPROTH. 1 Chym. Ann. 1790. p. 293. But this last seems less pure.

* Bergm. Jour. 1790. p. 465 † Ibid.

This ſubſtance is inſoluble in Acids. In a ſtrong heat it reddens but does not flame, in a crucible, however, a ſlight bluiſh flame but without any ſulphurous ſmell, is obſerved, undoubtedly from the decompoſition of water. Expoſed to a porcelain heat for ſeveral hours in a cloſed crucible, it intirely, or almoſt intirely, evaporates like Diamond. Under a muffle it is alſo almoſt intirely conſumed. Diſtilled, it yields a ſmall quantity of water, but no Air, Oil, Acid, or Alkali. Mixed with Tartar Vitriolate, it yields a liver of Sulphur, and projected on red hot melting Nitre, it deflagrates and alkalizes it; hence there is no doubt but it is a combuſtible ſubſtance, poſſeſſing both the external and internal characters of mere Coal, or Charcoal.

The Specific Gravity of the Carbon found near STRIDO was 1,415 as Mr. THOMPSON relates. The Specific Gravity of that found by Mr. WIDEMAN was 1,53. KLAPROTH found it to contain about 7 per cent. of ferruginous aſhes. That of LISWITZ is more impure, Mr. WIEGLEB found it to leave after calcination a reſiduum amounting to 12,5 per cent, of which the greater part was ſiliceous earth, and a very minute portion of Iron.

The Coal found near KILKENNY is alſo of this ſpecies, that which was formerly given to me as ſuch was ſpurious. Its colour is black, and when freſh broken, ſome parts of it frequently diſplay a violet colour. Its Luſtre 4. Metallic. Tranſparency, 0. Fracture foliated, and the courſe of the Lamellæ variouſly and confuſedly directed. Its fragments from 2 to 3, often coated with whitiſh illinitions.

Hardneſs 7. Specific Gravity 1,526.

Will

Will not burn till wholly ignited, and then flowly confumes, without caking, or emitting flame or fmoke.

266 Grains of it expofed to a heat of 27° of WEDGEWOOD for five hours and frequently ftirred did not coalefce, nor lofe their luftre until almoft nine-tenths had difappeared, and at laft left reddifh coloured Afhes amounting to 7,13 grains.

The CULM of WALES feems a variety of this fpecies, but lefs pure, differing from it chiefly in being more brittle, and emitting when ignited, a difagreeable fmell. Its colour black. Luftre from 3 to 4, not eafily kindled, but when ignited burns a long time without flame or fmoke, does not cake, and leaves but little afhes. Its Specific Gravity is 1,396.* It feems to be the GLANZKOHLE of WERNER.

The fhining black fcales found by Mr. WEDGEWOOD in the earth from SOUTH WALES, belongs alfo to this fpecies. Philof. Tranf. 1790. p. 316.

SMUT feems alfo a variety of this fpecies, but more impure. Its colour is black, deftitute of luftre, and looks like foot, ftains the fingers, is very light, in burning it barely glimmers; a black clay mixed with particles of Bituminous Carbon is alfo called by this name, in burning it gives out an offenfive fmell.

SPECIES II.

MINERAL CARBON,

IMPREGNATED WITH BITUMEN.

Of this fpecies I diftinguifh three families.

* 2 Watfon.

[redacted]

FIRST FAMILY.

MINERAL CARBON,

IMPREGNATED WITH *Maltha*, CANNEL COAL.

FIRST VARIETY.

COMPACT.

This is found chiefly in LANCASHIRE, its proper name is Candle Coal, as it burns like a Candle, but Candles in that ſhire are called Cannels.

It colour is black. Luſtre common. Tranſparency, o. Croſs fracture conchoidal.

Fragments from 2 to 3. Hardneſs from 7 to 8. Specific Gravity 1,273 per WATSON, or 1,232 by my trials, does not ſtain the fingers; eaſily kindles and burns with a large bright flame but of ſhort duration, and then leaves a ſooty reſiduum that difficultly burns; does not cake. 240 Grains of it heated until all the coaly part was conſumed, left 7,5 of reddiſh brown aſhes, moſtly Argillaceous and Siliceous.

100 Parts of it contain by my analyſis 75 Carbon, 21,7 Maltha, and 3,12 of Aſhes.*

* A particular account of this and the ſubſequent analyſes will be given at the end of this volume.

SECOND

SECOND VARIETY.

SLATY.

This Coal comes to us from SCOTLAND, where it is called SPLENT Coal. Its colour is greyiſh black, Luſtre 2, common. Tranſparency 0. Fracture partly ſlaty and partly imperfectly conchoidal.

Fragments 3. Hardneſs from 5 to 8, brittle. Specific Gravity 1,426, by my trials; burns as the former variety, but ſooner ceaſes to flame, does not cake, and leaves a ſtony reſiduum.

240 Grains of it treated as the former, left 50 grains of reddiſh grey aſhes.

100 Parts of it contain by my analyſis 47,6 Carbon, 31,6 MALTHA, and 20,8 of Aſhes.

I even doubt whether it contains ſo much Carbon, for the beſt ſpecimens diſcovered by the ſmell, when inflamed, a proportion of Sulphur.

SECOND FAMILY.

MINERAL CARBON,

IMPREGNATED WITH ASPHALT AND MALTHA, IN VARIOUS PROPORTIONS.

Pechkohle, Schieffer Kohle of Werner.

Its colour is more or leſs perfectly black, ſometimes preſenting bright reddiſh yellow illinitions. ſome-

ſometimes variegated; Luſtre from 2 to 4, ſeldom common, moſtly greaſy or Metallic. Tranſparency 0. Fracture various, moſtly foliated, plain or curved, large or ſmall granularly foliated, ſometimes in layers of contrary directions, ſometimes promiſcuouſly directed, ſometimes preſenting ſmall conchoidal diſtinct concretions, ſometimes ſtriated; often in the groſs, ſlaty. Its fragments 2, often oblong parallelopipeds. Hardneſs from 4 to 6. Specific Gravity from 1,25 to 1,37, ſtains the fingers, if moiſt, or diſintegrating, otherwiſe not. Inflames more ſlowly, but burns longer than the former family, and cakes more or leſs, according to the proportion of Aſphalt. It is often contaminated with lumps, or veins of Martial Pyrites, ſometimes with Allum, or interſected with veins of Spar.

Of this family there are numerous varieties, of which I ſhall deſcribe a few.

FIRST VARIETY.

FROM WHITEHAVEN.

Black. Luſtre 3, greaſy. Fracture plane foliated. Fragments 2. Hardneſs 6, very brittle. Specific Gravity, 1,257.

240 Grains of it expoſed to a heat of 27°, for five hours, after flaming a conſiderable time, caked, and at laſt left 14 grains of reddiſh Aſhes.

100 Parts of it contain by my analyſis 56,8 Carbon, and 33 of a Mixture of ASPHALT and MALTHA, in which the ASPHALT predominates.

SECOND

[redacted]

SECOND VARIETY.

FROM WIGGAN.

Black. Luſtre 3, greaſy, often with bright yellowiſh illinitions. Fracture foliated, ſome Laminæ uniformly, ſome promiſcuouſly directed, in the groſs ſlaty. Fragments 2. Hardneſs 6. Specific Gravity 1,268, burns more quickly than the former.

323 Grains of it expoſed in an open Crucible like the former, to a heat of 27°, for four hours, left a reſiduum of 5,13 grains of reddiſh brown Aſhes.

THIRD VARIETY.

FROM SWANSY.

Black. Luſtre 2. Fracture foliated, but from a contrary direction of the Lamellæ ſeems in part fibrous. Fragments 2, Hardneſs 5, very brittle. Specific Gravity 1,357. burns more ſlowly than the former varieties. 240 Grains of it treated as above, left 8 grains of yellowiſh red Aſhes.

100 Parts of it contain 73,53 of Carbon, 23,16 of a Mixture of Asphalt and Maltha, in which the former appears to predominate, and 3,22 of Aſhes.

FOURTH

FOURTH VARIETY.

FROM LEITRIM.

Black, Luftre 3. Fracture foliated. Fragments 2. Hardnefs 6, very brittle Specific Gravity 1,351. 240 Grains of it expofed to heat as before, left in three hours a refiduum of 12,5 of reddifh grey Afhes. 100 Parts of it contain 71,42 of Carbon, 23,37 of a Mixture of ASPHALT and MALTHA, in which the latter appears to predominate, and 5,21 of grey Afhes.

FIFTH VARIETY.

FROM IRWINE, IN SCOTLAND.

Black, prefents layers in contrary directions, hence often called Ribband Coal. Luftre of the alternate layers, 3. 2 Fracture fmall grained and courfe grained curved foliated.

Hardnefs from 4 to 5. Specific Gravity, 1,259. Its compofition I have not examined.

The fpecific Gravity of good Bituminous Coal never exceeds 1,4, except it contains fome quantity of interfperfed Pyrites.

THIRD FAMILY.

CARBON Bituminated, impregnated with a notable Proportion of Stony Matter.

SPURIOUS COAL.

I call the proportion of Stony Matter notable when it exceeds 25 per cent.

Its colour is greyifh black, Luftre 0. 1. Fracture flaty or earthy. Fragments quadrangular, 3. Hardnefs from 7 to 8. Specific Gravity from 1,500 to 1,600. It commonly explodes and burfts when heated; generally found amidft Strata of genuine Coal.

Buffon tells us that the Coal of Alaies is mixed with fuch a quantity of Limeftone, that it is often burned for the fole purpofe of obtaining lime from it. 2 Buffon Mineralog. 8vo. p. 189.

SPECIES III.

CARBON, loaded with stony matter:

Anthracolite of some.

Its colour is greyifh or brownifh black. Luftre from 3 to 4. Fracture in the grofs flaty. Its fragments Rhomboidal. Hardnefs from 6 to 7.

That found near St. SYMPHORIEN, analysed by SAGE contains, he assures us, neither Oil nor Bitumen; but after long ignition leaves a Residuum of 35 per cent. of slaty particles. 42 Roz. Jour. 76.

SPECIES IV.

CARBON, COMBINED WITH ONE-TENTH, OR ONE-EIGHTH OF ITS WEIGHT OF METALIC IRON.

PLUMBAGO. *Graphite of Werner, Reissbley of others. Blyertz of the Swedes.*

Its colour is dark Irongrey, or, if mixed with Ochre, brownish black; when cut, bluish grey. Found both in large and small kidney-form lumps. Sometimes disseminated. Lustre from 3 to 4. Metallic. Transparency 0. Fracture curved thin slaty, or indistinctly foliated. Fragments 2. presents exceeding fine grained distinct granular concretions. Hardness from 4 to 5. brittle.

Specific gravity 1,987 or 2,089. This last after absorption of water, Brisson found to weigh 2,150; and after exposure to heat, 2,300. And if then soaked in water, 2,410. Of that of GERMANY, 2,245, and after admission of water 2,276.

Marks black strongly. Feels somewhat greasy *.

Insoluble in the Mineral Acids. Heated before the blow-pipe it scarcely smokes, deposits no

* Karsten, Leske. O. 1870.

powder,

powder, is not altered by Borax or Microcosmic Salt, and does not effervesce or unite with fixed Alkalis.

It is found in ENGLAND, GERMANY, SPAIN, FRANCE, AMERICA, at the CAPE OF GOOD HOPE, &c. That of ENGLAND is the best, having the finest grain. That of SPAIN is mixed with Pyrites; that of AMERICA with Quartz and white Argill; that of the CAPE OF GOOD HOPE with yellow Argill and Pyrites*.

Plumbago is constantly formed in Iron Founderies, by the combination of the Charcoal employed in melting the Iron, with a certain proportion of that Metal, namely with from 9 to 12 per cent. as was observed by MAYER, RINMAN, and others, and confirmed by the experiments of VANDERMONDE, BERTHOLLET, and MONGE†. It is true Mr. PELLETIER found only 2 per cent. of Iron in Plumbago, which he had previously purified as he thought, by Marine Acid‡, but the Marine Acid had taken up the remainder.

The mixture of Earth always renders Plumbago coarser. The Iron is evidently in a Metallic state, and renders the Plumbago Magnetic. Chim. §, 201.

The Carbonaceous nature of Plumbago, was, for the first time, admirably developed by SCHEELE, and has since been confirmed by PELLETIER‡. It looses about 90 per cent. of its weight by exposure to a high heat, converts Phosphoric Acid into Phosphorus, the Arsenica into a Regulus; detonates with about ten times its weight of Nitre, &c.

* Mem. Paris 1786. p. 191.

† 27 Roz. Jour. p. 352.

‡ Ibid. p. 348.

GENUS IV.

VEGETO CARBONATED SUBSTANCES.

SPECIES I.

CARBONATED WOOD.

Of this there are three Varieties, the Ligniform, Scaly, and Compact.

FIRST VARIETY.

Ligniform Carbonated Wood. *Suturbrand.*

Its colour is bluish, or brown Lustre. o. its form flatted; its Fracture even or fibrous. It frequently preserves its branches, root and bark, but when it does not, its origin is easily discovered by its fibrous fracture, its epidermic texture, and the concentric circles of its annual growth. It is sometimes shot through with Quartz*. Hardness from 3 to 4. Mr. Bergman, Van Troil 355, found the Suturbrand of Iceland to yield after burning, 42 per cent. of Carbon, which is a much larger proportion than any natural Wood leaves when charred. Swed. Abhand. 1780. p. 35. It burns much more weakly than Pit-coal, and with a disagreeable smell.

* 1 Bergban. p. 64.

SECOND

SECOND VARIETY.

Scaly, or Earthy.

Its colour is alſo brown, or browniſh black, or browniſh red. Its Luſtre, 0. except where cut, and there 2. It is compoſed of Lamellæ which while moiſt are in ſome degree flexible, or even elaſtic. Its hardneſs 6. but ſometimes it is found of a looſe earthy conſiſtence, burns with an offenſive ſmell*, and moulders by expoſure to the air.

THIRD VARIETY.

COMPACT,

Piligno of the Italians,

BOVEY COAL.

Its colour the ſame as that of the former varieties. Luſtre 0. 2. Fracture fibrous, lamellar, or even; ſometimes Conchoidal, often in the groſs ſlaty. Hardneſs 6. Specific Gravity from 1,4 to 1,558. It burns with a weak creeping flame, often bluiſh, and an offenſive ſmell. Mr. Fabroni diſcovers its organic ſtructure by boiling it in dilute Nitrous Acid, as its fibres are thus laid bare. Dell Antracite p. 121. frequently contains Pyrites, Vitriol of Iron and Allum. Hiſt. Acad. Par. 1766. p. 140. in 8vo.

Mr. Fabroni found the Specific Gravity of the Pilignos of Italy from 1,4 to 1,558, and their

* 37 Roz. Jour p. 281. Fabroni Dell Antracite. p. 133.
‡ Berl Beob. p. 59.

their Carbonic contents to amount from 54 to 75 per cent.

Hence it is plain, that this Species of Coal is nothing else but wood, whose oil has undergone a change of the putrifactive kind, and that by this change its particles were in great measure disintegrated. The introduction of Sulphureous and Vitriolic particles seems merely accidental.

I am aware that many consider all Species of Pit Coal to be of Vegetable Origin, but let it be observed that Limestones, and many other Minerals contain fixed air, and that this air contains 27 per cent. of Carbon; this substance is therefore as antient as Limestones, and therefore dates from the origin of the Globe, in its present state.

SPECIES II.

Of Turf and Peat.

Turf and Peat differ from each other, in this, that the former contains the roots and stalks of various Moratic Vegetables, or of Heath, along with a mixture of real Peat. Whereas the latter, when pure contains no visible particles of any Vegetable. They are sometimes found together at different depths, sometimes separate, but sometimes these denominations are indiscriminately applied.

A Field containing Turf, or Turf and Peat, is called Bog or Moss; many Bogs contain only Turf; some, particularly those on which Heath grows, contain both.

Turf in its natural state, is a kind of semi-compact slimy mass formed of the particles of disintegrated Vegetables, such as leaves, roots and

and ſtalks, mixed with others, that are more or leſs perfectly carbonated, and alſo with the roots and ſtalks of other plants, in their natural ſtate, and more or leſs of Argill, Marl or Sand, all ſteeped in and impregnated with the bitter aſtringent juices of thoſe Vegetables. The ſuperficial beds of Turf contain the greateſt proportion of the roots of undecayed plants, and are therefore the worſt. The middle beds contain leſs of them, and therefore are better, the loweſt contain leaſt, and therefore are the beſt, when they contain none they are called PEAT.

PEAT, KLAPPER-TURF of the Swedes,* is a reddiſh or browniſh red ſlimy maſs, formed of the Carbonic particles of Vegetables, mixed with their aſtringent juices, and colorific oleaginous fæculæ. It hardens and blackens by expoſure to the air.

In HOLLAND Peat is formed of the ſlime found at the bottom of Canals, the Carbonic particles carried down by the RHINE, being gradually depoſited. Both Peat and Turf, contain various Saline Subſtances, no way eſſential to their compoſition, and frequently alſo Pyrites, as at MAUREGUY, near LAON †. The proportion of earthy and carbonaceous matter is variable, and on this depends much of the goodneſs of theſe ſubſtances. See the Analyſis of ACHARD. Mem. Berl. 1786. p. 35. 2 Chym. Ann. 1784. p. 241. and 2d. Chym. Ann. 1786. p. 338.

* Swediſh Abhandl. 1781 p. 259.

† 23 Roz. Jour. p. 1[illegible]

GENUS

GENUS 4.

VEGETO BITUMINOUS.

SPECIES I.

JET.

Its colour is pure black. Luſtre from 3 to 4. Tranſparency 0.

It is found only in detached maſſes, kidney-form, oblong, of from one inch to ſeven or eight feet long. It feels remarkably ſmooth, does not ſtain the fingers.

Its fracture ſtriated, and it ſplits more eaſily in the direction of the Striæ. Its hardneſs from 6 to 7.

The Specific Gravity of a piece extant in the King's Cabinet at Paris, was found by Brisson to be 1,259. Yet Buffon tells us it floats on water, and Muschenbrock will have its Specific Gravity 1,744.

It becomes ſlightly Electric by friction, and burns with a greeniſh flame, theſe properties, together with its fracture, and Luſtre clearly diſtinguiſh it from Cannel Coal, with which it has been often confounded, it ſeems nearly allied to the next Species.

SPECIES

SPECIES II.

AMBER,

BERNSTEIN AGTSTEIN, OF THE GERMANS.

Succinum, Electrum, Karabe.

Its principal colour is yellow, ſometimes riſing to the orange red, often paſſing to brown or blackiſh brown, more rarely white, or greeniſh. Luſtre 3. 2. Tranſparency 2, 3, 4, rarely 1.0, Fracture conchoidal. Fragments 2. Hardneſs 5. 6 . Specific Gravity from 1,078 to 1,085, per BRISSON It becomes electric by friction or heat, and emits an agreeable ſmlle It frequently contains inſects or particles of ſome vegetable. Heated, it ſoftens, ſwells, and then melts, and burns with a greeniſh or bluiſh flame, leaving a black coaly reſiduum, which by further combuſtion leaves a ſmall quantity of browniſh Martial Aſhes.

Diſtiled, it affords an Acid phlegm, which SCHEELE found to reſemble Vinegar, a whitiſh or yellowiſh Oil, a peculiar Volatil Acid, the reſiduum a Coal which amounts to about one twelfth of the whole, or rather about one fourteenth. Neither water, nor Alkalis in the moiſt way, nor eſſential Oils, nor any Acid but the Vitriolic have any action on it. Highly Rectified Spirit of Wine extracts a tincture from it. Æther ſoftens it, and if in fine powder imperfectly diſſolves it. But expreſſed fat Oils compleatly diſſolve it.*

* Stock. 11.

[redacted]

It is found in many Countries, but more particularly in PRUSSIA, at the depth of about 100 feet, reposing on Wood-coal in lumps of from half an ounce to four or five pounds.* and often on the Coast, particularly after storms.

It seems plainly of Vegetable Origin, but mineralized by some operation of Nature, similar to that, by which Animal Flesh is converted into a Substance resembling Spermaceti.

OF AMBERGRIS,

AMBRA OF THE GERMANS, AND COPAL.

Tho' these substances do not properly belong to the Mineral Kingdom, yet as some account of them is generally expected in Treatises of Mineralogy, I shall subjoin a few particulars relative to each, extracted chiefly from LEONHARDI's Dictionary.

The colour of AMBERGRIS is grey, or brown, or yellowish brown, spotted with black; generally found in the intestines of sick Spermaceti Whales, or floating in the Sea, in small rough lumps, rarely in large masses. Its lustre 0. Transparency 0.

Fracture earthy, generally contains bones of Fish or beaks of Birds.

Its hardness and consistence as that of wax. Specific Gravity from ,780 to 0,926. per BRISSON.

It is tasteless, but has a strong agreeable smell when warm. In a gentle heat it softens, and melts like wax; in a stronger it inflames, and if pure, leaves no residuum. 2 BERGMAN. p. 482.

* 2 Chym. Ann. 1791. p. 151.

Cold

[redacted]

Cold water has no effect on it, but to boiling it communicates its ſmell, and falls to pieces, being in ſome meaſure melted.

By Spirit of Wine, or fat Oils it is ſcarcely affected, the eſſential, as that of Turpentine, diſſolve it almoſt intirely, but Æther moſt perfectly.

Mr LEONARDI found it ſoluble in cauſtic fixed Alkalis, ſtill more ſo in Oil of Vitriol, and precipitable by water.

Diſtilled it yields an Acid phlegm, Oil, and as ſome ſay, a Volatil Salt, leaving a black ſhining reſiduum.

COPAL has generally a yellow colour, ſometimes light ſometimes dark, more rarely brown or whitiſh. Its Luſtre 2. Tranſparency 2. 4. 3. Fracture imperfectly conchoidal. Hardneſs 6. Brittle. Its Specific Gravity from 1,04 to 1,0[illegible]2. BRISSON.

Taſteleſs, and inodorous until heated, burns with a yellow flame, white ſmoke, and aromatic ſmell, leaving a coaly reſiduum.

Soluble in Æther and Ætherial Oils, but not in the fat; nor in Spirit of Wine but when firſt torrefied, and after long digeſtion both in cold and heat.

It ſeems to be the concrete juice of a tree found in VIRGINIA, called RHUS COPALINUM. Often contains inſects.

APPENDIX.

MELLILITE, Honigstein, of Werner.

Its colour is intermediate betwixt the Honey yellow and Hyacinth red, ſometimes inclining to the one, ſometimes to the other. It form that of ſmall quadrangular pyramids joined baſe to baſe, with ſmooth ſurfaces, but they are ſeldom found intire.

Luſtre 2, 3. Tranſparency 4.

Fracture conchoidal. Fragments 2. Hardneſs 5. Specific Gravity between 1 and 2,000.

It is not electric per ſe.

Heated it does not ſoften, nor does it inflame in a white heat, but becomes partly black and partly white, and then fumes, and falls into powder. Neither Spirit of Wine nor fat oils have any effect on it. Hence, if it has any right to be placed among Inflammable Subſtances, it muſt be looked upon as a Coal, united perhaps to an Acid. Bruckman thinks it a Gypſum impregnated with Petrol. It has, as yet been ſeldom found, and only ſeated on Wood Coal.

GENUS

GENUS 5.

SULPHUR AND ITS ORES.

SPECIES 1.

NATIVE SULPHUR.

Its colour is yellow generally with ſome ſhade of green; if permanently reddiſh or ſtreaked with red it contains Arſenic. That found near volcanos often becomes reddiſh in a ſhort time.*

It is found either in an aerial form, as in hepatic air, or concrete, either in looſe powder, or compact, and then either maſſive, ſtalactitic, orbicular, or capillary; either detached or in veins, or diſſeminated, or cryſtallized either in quadrangular pyramids, ſingle or joined baſe to baſe, or in triangular pyramids, or in tetrahædral or hexahædral priſms, or in cubes, or quadrangular plates, &c. generally ſmall or minute and implicated in each other.

Its Luſtre 2. greaſy. Tranſparency 2, 3, 4, 1, 0.

Fracture compact, conchoidal, or uneven, or ſplintery. Fragments 2. Hardneſs 4, 5. brittle.

Specific Gravity from 1,99. to 2,033. if higher it is impure. Taſteleſs, but by friction emits a peculiar ſmell and becomes electric. Heated to 170° of Fahr, it generally evaporates, melts at 185°. and then appears red. It inflames at 302°. its flame is blue and accompanied with a ſharp diſagreeable ſmell. When inflamed it abſorbs pure air, and thus becomes acidified, forming

* Mem. Paris 1770. in 8 vo.

Vitriolic

Vitriolic Acid, but in close vessels it sublimes, without any essential alteration, or an alteration proportioned to the quantity of pure air then absorbed, and forms Flowers of Sulphur. One part of Sulphur absorbs from one third to nearly an equal part of its weight of pure air, and thus forms VOLATILE SULPHUREOUS ACID, but when fully saturated with pure air, it takes from 2,33 to 2,5 times its weight of pure air, and then becomes fixed Vitriolic Acid.

It is reckoned insoluble in cold water, but HAHNEMANN tells us, that 3120 grains of boiling water take up one grain of Sulphur*. It is also insoluble in Spirit of Wine, unless both be in a vaporous state, and then [illegible] parts of Spirit of Wine take up 1 of Sulphur.

It is soluble in hot Oils, and also in Alkalis; in fixed Alkalis, both in the dry and moist way.

It is acidified by continued boiling in concentrated Nitrous Acid, and partly dissolved and partly acidified by boiling in the concentrated Vitriolic.

It is found in the greatest plenty in the neighbourhood of Volcanos or Pseudo-Volcanos, whether modern or extinct, as at SOLFATERRA, &c. Also, it is found in some Mineral Waters, or deposited as a crust on stones contiguous to them.

ANALYSIS OF SULPHUR.

To analyse Sulphur, let 500 grains of it be boiled with thirty or forty times its weight of water, which will take up any Neutral Salts it may contain.

2d. Let the undissolved residuum be treated with somewhat more than its own weight of Marine Acid, diluted with half its weight of

* 1 Chym. Ann. 1788. p. 182.

water

[redacted]

water and boiled, this will take up the Metallic S[illegible] may contain, and much of the Neutr[illegible] ve escape the water.

[illegible] ation continued a second t[illegible] trous Acid to the amount of half the quantity of the Marine Acid, to be certain that no Metallic Substance should escape.

4th. Let these different solutions be evaporated to one fourth. The Muriatic solution will depo-sit the Selenite it may have contained, the only Terrene Salt that can be supposed to have escaped the Aqueous Menstruum.

5th. Let both solutions be then mixed; the remainder of the process was thus conducted by WESTRUMB.

1st. As he suspected that much of the Acids had been dissipated during the evaporation, he added a few drops of Marine Acid and also of Alcohol, to accelerate the precipitation, and then inserted a piece of Zinc, this was soon covered with a brown exfoliating rind, these adhering particles he separated and found them to weigh only five grains. Part laid on the point of a knife evaporated with an Arsenical smell. So also, they did when heated on a silver spoon, and whitened a plate of Copper held over them.

Part was dissolved in Nitrous Acid, and this solution was tinged yellowish brown by Tincture of galls, whitish blue, by Prussian Alkali, Lemon yellow by hepatized water, dark lemon yellow by Sulphurated Alkali and greenish yellow by the solution of Copper in Volalkali. Hence the predominance of Arsenic was demonstrable; the remainder of the solution in which the Zinc had been inserted contained nothing but Zinc and some Calx of Iron.

2d. Having

2d. Having thus nearly determined the nature of the ingredients that fouled the sulphur, he repeated the analysis with [illegible] grains of it, and proceeding nearly as above, after separating the Selenite, he [illegible] the remainder of the solution, [illegible] and treated the residuum with a [illegible] quantity of water, the arsenic [illegible] the form of a white calx, [illegible] grains, It was soluble both [illegible] and exhibited the same ap[illegible] above tests as before, and was [illegible] by mixing it with Oil. The [illegible] treated with Caustic Volalkali, [illegible] grains of Calx of Iron.

[illegible] Sulphur, obtained from Copper [illegible] in appearance, was not free from [illegible], however on annalysing it he found no [illegible] Westrumb. p. 369.

[illegible] species we may annex Sulphur in an [illegible]

SPECIES II.

HEPATIC AIR.

It has a strong disagreeable smell. It burns [illegible] blue lambent flame when mixed with one [illegible] half times its bulk of common air, and [illegible] Sulphur. It explodes when burned with [illegible] equal bulk of pure Air.

It deposits Sulphur, when mixed with Vitriolic, [illegible], or Alkaline Airs.

Water absorbs from two thirds to nearly an equal bulk of this Air, the solution does not precipitate [illegible] water, but with the Nitrous solution of Silver [illegible] a black, brown, or reddish brown precipitate.

cipitate. It is heavier than common air, 100 Cubic Inches of it weigh, in the temperature of 67 degrees, Barometer 29,9. about 33 grains.

It is frequently found in Mineral Waters, and in caverns adjacent to volcanos, ſometimes alſo in Coal Mines, or in pits where water abounding with putrid animal ſubſtances repoſes.

SPECIES III.

SULPHUR COMBINED WITH ARGILL.

This is found at LA TOLFA, and has been already deſcribed among the Ores of Allum.

SPECIES IV.

SULPHUR INTIMATELY MIXED WITH ARGILL.

It is found near TARNOWITZ in SILESIA, and thus deſcribed by Mr. LEHMAN. Mem. Berl. 1756.

Its colour while moiſt is dark grey, when dry light grey. It is eaſily diffuſible in water like Marl. Slightly coherent, light, has a ſtrong peculiar ſmell reſembling that of Oil of Vitriol and Oil of Turpentine.

Heated, it loſes its ſmell and hardens, aſſuming a fleſh colour. In a high heat the Sulphur ſublimes.

100 Parts of it contain about ſix or eight grains of Sulphur. Alkalis in the dry way, take up its

Sulphur, but not in the moiſt. Other varieties of this Species, of a greeniſh, or black colour are ſaid to be found in the vicinity of volcanos, and alſo at TARNOWITZ. FIBIG. 238. It is often impregnated with Petrol.

SPECIES V.

SULPHUR UNITED TO CALCAREOUS EARTH.

Its colour is greyiſh blue, or bluiſh grey. Its Luſtre, 0, 1, 2. Fracture earthy. Hardneſs, 5, 6. Smells Sulphureous, at leaſt when ſtruck or rubbed.

Efferveſces with Acids, with a ſtrong Sulphureous ſmell. Found near Hepatic Waters, which frequently hold it in ſolution,* alſo in the neighbourhood of volcanos.

SPECIES VI.

SULPHUR UNITED TO FIXED ALKALIS.

This is found in ſome Mineral Waters, the Sulphur is eaſily diſtinguiſhed by its ſmell and precipitating the ſolution of ſilver black, &c. See 2 WESTRUMB. 4 HEFT. p. 130.

* Mem. Paris 1750. in Octavo, p. 291. and 2 Weſtrumb p. 131.

SPECIES

SPECIES VII.

SULPHUR UNITED WITH METALLIC SUBSTANCES.

Tho' Sulphur enters into combination with moſt Metallic Subſtances, and is even one of their principal Mineralizers, yet as it is the leaſt notable part in moſt of theſe Ores, which are principally conſidered with reſpect to their Metallic part, ſuch compounds may more properly be introduced in the fourth part of this Treatiſe.

There is one of them however, which is attended to chiefly by reaſon of its Sulphureous part, and ſcarce ever treated as a Metallic Ore to obtain Metal from it; this is the compound of Sulphur and Iron, called MARTIAL PYRITES, ſo, SULPHUR PYRITES and often ſimply Pyrites, it being the moſt common of all the compounds to which this name is given. This then may moſt properly be placed here.

Pyrites is a name antiently given to any Metallic compound that gave fire with ſteel exhaling at the ſame time, a Sulphureous or Arſenical ſmell. At preſent four compounds are known by that name, namely that of Sulphur and Iron, Arſenic and Iron, a compound of Sulphur and Copper, much reſembling the former, and a compound of Tin and Sulphur.

Hence we have Sulphur Pyrites, Arſenical Pyrites, Copper Pyrites, and Tin Pyrites.

[redacted]

SPECIES VIII.

SULPHUR COMBINED WITH IRON OR CALX OF IRON, MARTIAL PYRITES.

Sulphur kiefs of Werner.

Of this ſpecies I diſtinguiſh two Families. 1ſt. That which contains Iron in its Metallic ſtate naturally or artificially efflorefcible, and thus convertible into Vitriol of Iron.

2d. That which is not convertible into Vitriol of Iron, but affords the brown Iron Ore.

FIRST FAMILY.

SULPHUR UNITED TO IRON IN ITS METALLIC STATE.

Of this family there are four Varieties.

FIRST VARIETY.

COMMON SULPHUR PYRITES.

Gemeiner Sulphur kiefs of Werner.

Its colour, is pale or Braſs yellow, ſometimes ning to brown, ſometimes tarniſhed or mutably

tably variegated. It is found maſſive, diſſeminated, inveſting, or inherent, or variouſly cryſtallized, in ſmall or minute cubes, octohædrons, dodecahædrons, &c. alſo globular, elliptical, kidney-form, cellular, tuberoſe, arboreſcent, &c. External Luſtre, 4, 3, internal 2. Metallic. Tranſparency 0. Fracture uneven, fine or courſe grained, ſometimes tending to the conchoidal. Fragments, 3. Hardneſs, 10. brittle. Specific Gravity from 3,9 (BRISSON) to 4,6 that of a perfect cube which I tried; by friction it exhales a Sulphureous ſmell. It is not Magnetic. It decrepitates, and when heated red hot, loſes its yellow colour, and becomes partly of an Iron grey, and partly (namely on the ſurface expoſed to the Air,) of a bright red. In a heat of 102 degrees of WEDGEWOOD's Pyrom. it melts in a covered crucible into a bluiſh grey ſlagg, ſomewhat porous internally.

It is ſoluble in the Nitrous Acid with plentiful red fumes, but no Sulphur is ſeparated till towards the end. The pure Air of the Nitrous Acid firſt converting the Sulphur into Vitriolic Acid—In the Marine, with the aſſiſtance of heat; but ſcarce at all in the Vitriolic.

The Amorphous often forms intire Strata; it is frequent in Coal Mines. The Globular occurs often in beds of Clay or Chalk, the Cubic and Figured in Argillites.

Before the Blow-pipe it emits a ſtrong Sulphureous ſmell, burns at firſt with a blue flame*, and leaves a browniſh bead, which tinges Borax of a ſmutty green; otherwiſe, if further heated, it reddens

* 2 Bergm. p. 499.

SECOND

[illegible]OND VARIETY.

STRIATED.

[illegible] kies of Werner.

[illegible] when fresh broken, are much the [illegible] of the former Variety, but more [illegible] tarnished, passing into variega[illegible] those of a Pidgeon's neck or a [illegible] or bright bluish grey like Steel, or [illegible] the Gold yellow. Found reniform, [illegible] orbicular, or crystallized in small [illegible] pyramids united in a common basis, [illegible]comb, or eight sided figures, &c. [illegible] grouped together, and implicated in [illegible]

[illegible] Lustre, when undecayed 3. 4. Metal[illegible] 2. Transparency. 0.

[illegible] sometimes coarse and broad, some[illegible] parallel, or divergingly *striated* or [illegible]

[illegible] 3. presenting curved Lamellar dis[illegible] turned inwards.

[illegible] to brittle. Specific Gravity from [illegible] 4,1. BRISSON.

[illegible] respects like the former Variety.

It more readily withers by exposure to the Air [illegible] the former Variety. It is not Magnetic.

[illegible] the Blow-pipe its results correspond with those of the former Variety.

THIRD

THIRD VARIETY.

CAPILLARY,

Haarkies of Werner.

Its colour generally Steel grey, or intermediate between that and the pale yellow. Found in hexangular, or octangular, acicular cryſtals, either parallel or diverging from a common centre, or Capillary and woolly, or interwoven Luſtre, 3. Metallic. Tranſparency, 0.

This Variety is the leaſt common.

FOURTH VARIETY.

MAGNETIC,

Magnetiſcher eiſen kies of Werner.

Its colour is intermediate between the Tombac brown, Copper red, and Braſs yellow; ſometimes approaching to the one, ſometimes to the other, often Irideſcently tarniſhed. Found diſſeminated and maſſive. Luſtre, 2. Metallic. Tranſparency, 0.

Fracture compact, inclining to the ſmall conchoidal and uneven. Fragments, 2.

Hardneſs 8.9. brittle. Specific Gravity exceeds 3. but I had no ſpecimen fit for trial.

Slightly Magnetic. And hence appears to contain leſs Sulphur, than the foregoing Varieties. See RINMAN §. 36. Hence, when treated with the Blow-pipe, it does not give out ſo ſtrong a ſmell of Sulphur, but melts into a greyiſh black bead,

bead, which is alſo Magnetic: with Borax it efferveſce, and gives it a black tinge.

OBSERVATIONS.

Of the foregoing Varieties, there are ſome that SPONTANEOUSLY effloreſce and vitriolize, as particularly thoſe of the Second Variety, and ſuch of the firſt, as are brittle, but there are others, particularly the cubic, and ſuch of the amorphous as are difficultly frangible, that will not effloreſce and vitriolize until they are torrefied, or deprived of part of their Sulphur, by diſtillation in a graduated heat. Hence, it is plain, that an exceſs of Sulphur, prevents in ſome, and perhaps of hardneſs in others, their ſpontaneous effloreſcence, and conſequently to produce this effect, the Sulphur and Iron ſhould be, to each other in a certain proportion. Now, from various experiments, it appears that this proportion is from nearly equal parts Sulphur and Iron, to that of one part Sulphur to two of Iron. Thus Mr. BAUME, found that a moiſt mixture of equal parts Sulphur and Iron ſwell, and at laſt inflames as Pyrites often ſpontaneouſly do. 1 BAUME p. 611.

HASSENFRAZ found that Pyrites, juſt ready to effloreſce contained Sulphur and Iron, in the proportion of 5,5 Sulphur to 4,5 of Iron, which is that of 1,222 to 1. 30 Roz Jour. p. 421.

RINMAN obſerved a mixture of two parts Iron, and one part Sulphur moiſtened, to ſwell and burſt after a few hours. This agrees alſo with the experiments of HENCKEL, who conſtantly found the proportion of Sulphur extractable from Pyrites, to be between one-third and one-

one-fourth of their weight, and it is well known, and he acknowledges it, that the whole of the Sulphur they contain can never be obtained by distillation the mode of extracting it, he employed; it is even possible that the proportion of Sulphur may be still smaller, for SCHEELE found that a mixture of three parts Iron, and one of Sulphur moistened, acted on each other, and became black. §. 10. but such mixtures are never perfect. MONNET also obtained striated yellow Pyrites by melting four parts Iron and one of Sulphur, the compound weighed only 4,5 and consequently contained only one-ninth of its weight of Sulphur,* but he does not inform us whether this compound was efflorescible, I suppose not; on the other hand Mr. HASSENFRAZ found Pyrites that contained Sulphur and Iron, in the proportion of three to two incapable of efflorescence.† It is possible however, that Pyrites incapable of efflorescence, may contain too little Sulphur, for Mr. MONNET tells us, that Pyrites that yield one-fifth of Sulphur (consequently contain about one-fourth) are incapable of efflorescence, and with Alkali give Liver of Sulphur by fusion; and that Cubic Pyrites tho' incapable of efflorescence do not afford a Liver of Sulphur with Alkalis.‡ Whence, it may be infered that they contain too little Sulphur; to determine this point, I reduced a quantity of Cubic Pyrites, which lay by twelve years without efflorescence, to a fine powder, and mixed 240 grains of it with 320 grains of dry Tartarin,

* Monnet Vitriolization. p. 194.

† 30 Roz. Jour. p. 421.

‡ Monnet Vitriolization. p. 200.

 and

and kept the mixture in a low white heat, for 15 minutes; it being then completely fufed, I poured it out; the melted mafs, was of a dark green colour, but internally lighter, and brighter, tho' it foon tarnifhed, and became purplifh. It weighed (befides what ftuck to the crucible) 291 grains. This fpeedily diffolved in water, the folution was green, fmelled ftrongly of Sulphur, and on adding Marine Acid, it immediately gave a LAC SULPHURIS. In a word, it was a compleat Martial Liver of Sulphur.

2d. As to the ftate of the Iron, it appears clearly to me, that the Iron, in Pyrites, fpontaneoufly Vitriolizable, is in its Metallic State before any efflorefcence appears. 1ft. Becaufe in all the artificial mixtures of Iron and Sulphur, which blackened, fwoll, heated and vitriolized like Pyrites, as in thofe of BAUME. LEMERY, SCHEELE, RINMAN and my own, the Iron employed was conftantly Metallic Iron: 2d. Becaufe RINMAN found mixtures of Sulphur and Iron, in the ftate of Æthiops, and SCHEELE thofe of Sulphur and Iron in the ftate of Crocus to be incapable of heating and acting on each other. RINMAN § 252. b. c. SCHEELE § 81. 3d. Becaufe the folution of Pyrites in the Marine Acid, affumes a green colour, which is the colour it receives from Iron, in its Metallic State, and never from Calces of Iron. 4th. Becaufe the decompofition of water, is always the firft fymptom of efflorefcence, and this can be produced only by Iron, in its Metallic State. I need not dwell on the arguments of BERGMAN, SCHEELE and ELHUYART, to the contrary, as in this more advanced ftate of the fcience they are of no importance.

SECOND

SECOND FAMILY.

SULPHUR UNITED TO CALX OF IRON, AND CONVERTIBLE INTO HEPATIC OR BROWN IRON ORE.

HEPATIC PYRITES,

Leber Pyrites of Werner. Waſſer Kies of Others.

Its colour approaches to the Steel grey, or is intermediate between the pale yellow, and Steel grey, ſometimes variouſly tarniſhed, (generally browniſh black,) by expoſure to the Air.

It is found cryſtallized like the firſt variety,* or maſſive or diſſeminated, or ſtalactitic, reniform, tubular, cellular, arboreſcent, reticular, orbicular, tabular, &c. Its ſurface often ſtriated.

External Luſtre 2. Internal 1. Metallic. Tranſparency 0.

Fracture Even, Uneven, or inclining to the Conchoidal. Hardneſs from 9 to 10.

Specific Gravity from 3,477 to 3,502. BRISSON. Luſtre of its ſtreak. 2. 3.

Expoſed to air and moiſtened, it does not effloreſce † as Mr. MAQUART has experienced. Yet others ſay that Capillary Cryſtals ſometimes ſpring out of it; theſe probably proceed from a mixture of Argill. They contain but very little Sulphur, ſometimes none. MONNET VITRIOLIZATION. 26.

* 3 Romé de Liſle, p. 266.
† Maquart, p. 125.

If we may believe Mr. ROME DE LISLE this sort of Pyrites differs no way from the former family

According to him, one and the same species of Pyrites exposed to MOIST air effloresces and Vitriolizes, and exposed to DRY WARM air, suffers a gradual decomposition by the loss of its Sulphur, without any alteration of its shape, and by absorbing fixed air, is converted into brown or Hepatic Iron Ore.*

In the former case, he tells us the alteration begins at the center of the Pyrites, and gradually extends to the surface, in the latter the contrary happens; but this is a mistake, for in both cases, the alteration evidently begins at the surface, as I have often remarked The cause of his mistake arose from his finding calx of Iron in the interior of many Pyrites whose surface was found, but this calx like many other heterogeneous substances was most probably ever more contained in it By such fanciful deductions GUSMAN and CARROSI have been led to think that different species of Stones and Metals are transmuted into each other, a notion abundantly confuted by GEORGI and FERBER.

However it appears by the more credible testimony of Mr MAQUART † that there really are Pyrites differing externally but little from the first variety of the former family, which do not effloresce but are decomposed by the loss of their Sulphur, and converted into brown Iron Ore His own Analysis which was scientifically conducted, convinces me that these Pyrites,

* 16 Roz. p. 247 and 248.

† Maquart Mem. Mineral. p. 97 &c. 112. 128 and 41 Roz 6.

(namely thoſe I aſſign to this family,) are very different from thoſe of the firſt, and the difference conſiſts in this, that in theſe the Sulphur is united to Iron rather more oxygenated than Æthiops, and not as in the former, to Iron in its Metallic ſtate. This being granted, we ſee 1ſt. Why they are inſoluble in Marine Acid as he aſſerts, 2nd. Why they do not heat and effloreſce as the Pyrites of the former family, 3rd. Why they contain, when decompoſed, fixed air, as Iron in this ſtate powerfully attracts it as is well known, for Æthiops expoſed to the open air ſoon ruſts. That Calces of Iron may unite to Sulphur admits of no doubt*. By MAQUART's Analyſis, 100 parts of theſe Pyrites contain 55,5 of Calx of Iron, 37,5 of Sulphur, and 5 Silex, hence we ſee the Iron and Sulphur are in the proper proportion for vitriolization, and conſequently that the STATE of the Iron is the only obſtacle to it I make no doubt nevertheleſs, but by torrefaction ſuch Pyrites might be brought to Vitriolize, as the pure air would then unite to the Sulphur and form Vitriolic Acid.

Pyrites *Eſſentially* conſiſt of nothing elſe than Sulphur and Iron, but many, particularly thoſe found in clay, contain alſo Argill, and thoſe found in Chalk contain that ſubſtance.† The property of effloreſcing does not depend on any of thoſe foreign ingredients, as ſome of thoſe that poſſeſs them effloreſce, others not, but depends ſolely on the proportion of the Sulphur and Iron to each other, on the STATE of the Iron, and the greater or leſſer compactneſs of the com-

* Monnet Vitriolization, p. 286. and Bergm.

† Monnet Mineralogy. p 339. Eaux. Minerales. p. 2,6. 298. 1 Bergm. 295. 30 Roz. Jour. p. 420.

pound

pound which renders it capable or incapable of admitting air and moisture.* According to MONNET, the best Pyrites afford two-thirds of their weight of Vitriol.†

TO ANALYSE PYRITES.

a Let 200 grains of it finely pulverised be gradually projected in small portions into six times its weight of hot strong Nitrous Acid, to convert the Sulphur into Vitriolic Acid. *b* Let the solution be poured off, the residuum well washed, and the washings added to the solution. *c* To the liquor thus obtained let Marine Acid be added, and the whole then precipitated by the solution of Muriated BARYTES. Baroselenite will be obtained, and the Iron and Earth which the Vitriolic Acid might have taken up, will unite to the Marine Acid. The Barytic precipitate thus obtained, dried, and heated in a low red heat for half an hour, will, by its weight indicate the quantity of real Vitriolic Acid contained in it, as 100 grains Baroselenite contain 32.56 of real Vitriolic Acid, and the quantity of Vitriolic Acid being known, that of the Sulphur from which it originated may be deduced, as 100 parts real Vitriolic Acid contain about 30 of Sulphur. If any Sulphur should still remain in the residuum *a*, let it be boiled in a fresh portion of Nitrous Acid, edulcorated and the liquor treated with Muriated Barytes as before.

The quantity of Sulphur being thus found we next proceed to find that of Iron. Let the residuum *b* be repeatedly digested in Marine

* 30 Roz. Journ p 4 420.
† Monnet Vitriolization p. 22.

Acid,

Acid, and at laſt, with Aqua Regia containing two-thirds Marine Acid, and the ſolution added to that from which the Vitriolic Acid was extracted *b*, and both treated with Pruſſian Alkali, as direct-ed in the former volume, the quantity of Metallic Iron is determined, as there ſhewn.

The ſolution may ſtill contain Argill, and Calx which are to be ſeparated by Cauſtic Volalkali, as already ſeen.

The undiſſolved reſiduum can now conſiſt only of Silex, or Selenite and Silex, which are to be ſeperated as already indicated, and the quantity of Vitriolic Acid eſtimated, to deduce that of Sulphur.

To find the ferruginous contents of Pyrites in the dry way, let them be reduced to powder and well roaſted. Then with four parts of the torrefied and pulverized maſs mix two of quicklime, two of Fluor, 1,5 of Charcoal, and four of decrepi-tated Common Salt; place the mixture in a cru-cible, lined with Charcoal; to which a cover ſhould be luted; the lute being dry commit it to a Smith's Forge, giving a moderate heat for a quarter of an hour, and the ſtrongeſt for the re-mainder of the hour. A regulus will be found.

In GERMANY, HUNGARY and SWEDEN Sul-phur is chiefly obtained by extraction from Py-rites. See SCHUTTER, 222. and 2 LEONHARDI'S Diction p. 220. In England it is moſtly pro-cured from SOLFATERRA or SICILY.

Sulphur is diſcovered in Earths and Stones either by its Inflammation, or by its ſublimation with or without Arſenic or Mercury, or by fuſi-on with fixed Alkalis, or by the Hepatic Air it yields when its matrix is treated with Marine Acid.

PART IV.

METALLIC SUBSTANCES.

METALLIC SUBSTANCES when in their perfect ſtate, and unalloyed with each other, preſent the following characters.

Their COLOUR is Orange red, more or leſs dilute, or yellowiſh red, or reddiſh yellow, or pure white, or reddiſh white, or bluiſh white more or leſs dilute, or whitiſh grey, or bluiſh grey.

LUSTRE. 4, 3, 2. TRANSPARENCY, 0.

FRACTURE Hackly, granularly foliated, or ſtriated.

FRAGMENTS, 4, 3.

HARDNESS from 5 to 12. SPECIFIC GRAVITY from 6 to 23.

All are ſoluble either in Nitrous Acid, or Aqua Regia, and precipitable therefrom by Cauſtic or aerated Alkalis,* or (Platina excepted) by Pruſſian Alkali. All are fuſible by ſome degree of heat, and when in fuſion, aſſume a convex ſurface, or, if in ſmall quantity, a globular. If calcined and not too volatil, they communicate a tinge to Borax or Microcoſmic Salt after fuſion, or render them Opake.

* The precipitates however are often re-diſſolved.

When

When perfectly fuſed, they are for the moſt part miſcible or combinable with each other, but refuſe to mix with their own Calces,* or with other Unmetallic Suſtances, except with Sulphur, Phoſphorus and Charcoal, and the Acids of the two former, which unite with moſt of them.

There are ſeventeen Metallic Subſtances capable of being preſented under a Metallic appearance now known GOLD, PLATINA, SILVER, COPPER, IRON, LEAD, TIN, QUICKSILVER, ANTIMONY, REGULUS OF ARSENIC, BISMUTH, COBALT, NICKEL, REGULUS OF MANGANESE, URANITE, SYLVANITE and TITANITE. And three whose capacity of exhibiting that appearance is ſomewhat doubtful. Molybdena, Wolfram, and Menachanite.

Of theſe, the three firſt and Quickſilver are commonly called NOBLE AND PERFECT METALS, becauſe when calcined they recover their Metallic appearance and other properties, without the addition of any Combuſtible Subſtance, by mere heat. Whereas Copper, Iron, Lead, and Tin, cannot well be reduced without ſuch addition. And hence are called BASE and IMPERFECT Metals. But all the above mentioned (even Quickſilver, when rendered ſolid by cold) are Malleable to a great degree, and hence are called INTIRE Metals, whereas Zinc, Regulus of Antimony and the remainder, are either not at all, or very ſlightly Malleable, and hence are called SEMI-METALS. Some Mineralogiſts reject this diſtinction, becauſe a diminiſhing progreſſion of Malleability may be obſerved among many of them, if this reaſon were valid we ſhould alſo reject the diſtinction of Salts and Earths, nay even that be-

* Except Iron.

tween Vegetables and Animals, as their boundaries can ſcarce be aſcertained; abſurdities generally rejected by the common ſenſe of mankind: there is even a marked diſtinction between the Noble and the Imperfect or Semi-Metallic Subſtances, for Quickſilver will carry over the latter in diſtillation, but not the former. A few years ago even the ſimple Earths were upon very plauſible appearances thought ſuſceptible of Metallization. The deception however was ſoon diſcovered and traced to its ſource by SAVARESI, KLAPROTH, WESTRUMB, and TIHAUSKI.

Metals on which nature has beſtowed their proper Metallic appearance, or which are alloyed only with other Metals or Semi-Metals, are called NATIVE. But thoſe that are diſtinguiſhed (as they commonly are in Mines) by combination with ſome Unmetallic or Unmetallized Subſtance, are ſaid to be MINERALIZED. The ſubſtance that ſets them in that ſtate is called a MINERALIZER, and the compound of both, an ORE. A term whoſe ſignification alſo comprehends the Stones and Earths which contain Metallic Subſtances whether NATIVE or MINERALIZED in a NOTABLE proportion.

When the Mineralizer is of a Saline nature, and renders the Metallic matter ſoluble in leſs than twenty times its weight of water, the compound is generally claſſed with SALTS; thus the Vitriols of Iron, Copper, and Zinc, are generally claſſed with Salts; but if they are conſidered chiefly with reſpect to their Metallic baſis, as Vitriols of Cobalt and Nickel, they are ranged among ORES. Of all Mineralizers the moſt common is PURE AIR in its concrete ſtate, to which fixed air is often ſuperadded. Next to this Sulphur, and Arſenic in its calcined ſtate frequently occur,

occur; the Vitriolic, Marine, Phoſphoric, Arſenical, and Molybdenous Acids are leſs commonly met with. Sulphur and Arſenic generally communicate a Metallic Luſtre, other Mineralizers, at moſt a Saline or Cryſtalline appearance to the Metals they degrade.

In ſome caſes Sulphur unites to Metallic Subſtances uncalcined, in other caſes it is found ſuperadded to them in their calcined ſtate, as I have already noticed in treating of Pyrites. This diſtinction is not without its uſe, as it often ſerves as a guide to the proper mode of treating them, and of eſtimating their quantity in the Ore previous to any treatment. A few Mineralogiſts, but of great reſpectability, were inclined to reject Arſenic from the rank of Mineralizers, as they deemed it, when united with Metals to exiſt in its reguline form, but as it is now certain that even the Acid of Arſenic exiſts as a Mineralizer, I ſee no reaſon to deny that its Calx, which is certainly Semi-acidified, may without reduction perform the ſame function.

In taking the Specific Gravity of Ores they muſt be ſeparated as much as poſſible from all earthy and ſtony particles.

In ſtating the reſults of the Analyſis of Ores, I have not mentioned the quantity of perfect Metal to which that of any Calx, or Saline Metallic compound correſponds, to avoid repetition, as it may at once be found by conſulting the Tables at the end of this volume.

CHAP. I.

GOLD.

Its colour is Orange red, or reddish yellow. Lustre 4. Fracture Hackly. Hardness, 6. Specific Gravity. 19,3.

It is soluble only in Aqua Regia, or the Oxymuriated Acid. And precipitable therefrom by a fresh made solution of Tin, or Tin Foil, with a purplish colour, or in its Metallic form by a solution of Vitriol of Iron.

Gold melts at thirty two degrees of WEDGEWOOD's Pyrometer; being exposed to the utmost force of Mr. PARKER's burning Lens for some hours, it lost no sensible part of its weight. Yet when in contact with earthy matters it communicated a blue or purple tinge to them. Mr. LAVOISIER observed a plate of Silver, held over Gold fused by the heat of pure air, *perceptibly* Gilt, which might well happen without any perceptible loss of weight. If this heat were long continued, it is plain the whole would be volatilized. In Mr. MAQUER and EHRMAN's experiments, the Gold was evidently impure, no conclusion can therefore be drawn from them. It appears also that in such high heats Gold may be calcined.

Gold being incapable in low heats of uniting with pure Air, Sulphur, Arsenic or any Acid furnished by Nature, it is plain it can never be Mineralized in the strict sense of this word. The Gold

Gold Ore of NAGAYA is not an exception to this obſervation, as we ſhall ſoon ſee.

SPECIES I.

NATIVE GOLD.

Its colour yellow, more or leſs dilute, or browniſh red, like SPANISH ſnuff, malleable and flexible. Found either in compact maſſes*, or in ſpangles, inlaying, or diſſeminated, or capillary, Arboreſcent, ramified, interwoven, or dentiform, or cryſtallized in cubic, pyramidal, priſmatic or tabular forms; or in grains viſibly or inviſibly mixed with various other ſubſtances. External Luſtre 3. Internal, 2. Metallic. Fracture Hackly. Hardneſs, 5.

Specific Gravity exceeds 12 more or leſs in proportion to the quantity of Silver or Copper with which it is commonly alloyed, and the Cavities it may contain.

The ſubſtances in, or on which it is found, are either ſtony, ſandy, earthy, or inflammable, or Ores of other Metallic ſubſtances.

IN STONY, SANDY, OR EARTHY SUBSTANCES.

Of the firſt, the moſt common is Quartz, Siliceous Shiſtus, Hornſtone, Sandſtone, Spar, Gypſum, &c. In HUNGARY, TRANSYLVANIA, BOHEMIA, &c. or TRAP, or JASPER, FELSPAR, or in clays, as in BOHEMIA, or in the Sand of

* The largeſt ſpecimen of Native Gold found in Europe as yet known, is that lately diſcovered in the county of Wicklow. It weighs twenty two ounces. Several other pieces exceeding an ounce have alſo been found at the ſame place, in ſand covered with turf, and adjacent to a rivulet.

various

various Rivers, in different Countries as HUNGARY, FRANCE, AFRICA, &c. particularly in the yellowish red, and Violet Sands. It is so generally interspersed thro' Earths of various kinds, that Mr. BERGMAN thinks it more extensively diffused, tho' in exceeding small quantities, than any other Metal, except Iron. 2 ERDE BESCHREIB, p. 313. If one hundred pounds of Sand contain 24 grains of Gold, it is said the separation is worth attention. In AFRICA five pounds of Sand often contain 63 grains of Gold. The heaviest, which is often black or red, yields most.

Gold interspersed through Sand, is often separated by mere Mechanical means, amply described in the PARIS Memoirs for 1718, and 1786. In BORN's Letters from HUNGARY, and in DIEDRIC's *Description des Gites des Minerais*. Vol. 1. p 1.

When it is embodyed in earths or stones, these may be essayed in the moist way by reducing them to a very fine powder, weighing a determined portion, and effecting their solution, if *Calcareous* in Nitrous Acid, which will take up the Matrix and leave the Gold at bottom untouched; or, if *Gypseous* or *Siliceous* by digesting them in Aqua Regia as long as any Metallic substance is taken up, which the solution of Tin or Prussian Alkali will indicate, and then precipitating the Gold by a dilute solution of Vitriol of Iron; or by *Amalgamation*, with six times their weight of quicksilver, in a Copper, Iron, or even wooden churn, in which hot quicksilver and pulverized Sand are placed, and kept agitated, now and then adding boiling water. The Quicksilver thus takes up the Gold from which it may be separated by distillation. But for this operation see BARON BORN's improved method. Or by heating the sand

ſand red hot, quenching it three or four times in water, then melting it with twice its weight of Litharge, reviving the Litharge by Charcoal into Lead, and laſtly freeing the Gold from the Lead by cuppellation. LEWIS's Commer. p. 194.

OR IN THE DRY WAY, by fuſion with Alkali and Liver of Sulphur, and the ſubſequent decompoſition of the latter by Iron.

Native Gold, as already ſaid, is ſcarce ever found perfectly pure, being alloyed with Silver, or Copper, or Iron, or all three; if ſuch alloy be diſſolved in Aqua Regia, Muriated Silver will fall during the ſolution, which being waſhed and dried in a heat of 212° gives the weight of the Silver, it being $\frac{75}{100}$ of the Muriated Silver. The Gold may then be precipitated by a copious addition of the dilute ſolution of Vitriol of Iron. The Copper by a poliſhed plate of Iron of known weight.

In the dry way Gold may be ſeparated from moſt other Metals by melting the alloy with three times its weight of pure Antimony, as the Sulphur of the Antimony will ſcorify moſt other Metals while the reguline part will unite with the Gold from which it is afterwards to be ſeparated by fuſion and blaſting. See LEWIS's Commer. Philoſoph. p. 156.

IN SULPHURATED ORES.

1ſt. Native Gold is ſometimes inviſibly diſperſed and diſguiſed, ſometimes viſibly contained in the form of a browniſh red powder in MARTIAL PYRITES, as in that of ADELFORS in SWEDEN, and alſo in NORWAY, BOHEMIA, and SIBERIA.

SIBERIA. It seems now agreed that it is not really Mineralized in these Ores. 1 BERGB. p. 8 and 89 2 BERGB. p. 227. Philosop. Transf. 1719. p. 527. For it is often extracted from them by the mere mechanical means of pounding and washing, or at least from the residuum left after solution in the Nitrous Acid; its quantity is generally very small, scarcely above 8 grains in 10,000 of the Ore, or one ounce, or one and a half ounces in a hundred weight of the Ore. ENGESTROM in Cronsted. p. 299. That of NAGEBAY in TRANSYLVANIA however contains 12,5 per cent. of Gold. 2 RAAB. p. 461.

To analyse these Ores, Mr. BERGMAN recommends digestion in dilute Nitrous Acid,* in a heat of 150 degrees of Fahr. The Menstruum to be gradually added in the proportion of about six times the weight of the Ore each time; about 12 or 16 times the weight of the Ore should be employed.

When the Gold only is sought, the Ore should previously be roasted. The solution being effected and diluted, should be filtered, and the Sulphur thus collected, washed, dried, and weighed. The residuum will contain the Gold and the insoluble Matrix, which he advises to separate by washing.

To discover the remaining ingredients he requires the solution to be evaporated to dryness, heated to redness and weighed, then if it contains Copper this should be extracted by Volalkali. If Manganese, which it generally does, this should be extracted by dilute Nitrous Acid and Sugar. If Silver, this will be taken up by the pure Nitrous Acid. If Zinc, this will be taken up by

* By dilute Nitrous Acid he means that whose Specific Gravity is below 1,200. 2 Bergm. p. 406.

any

any Menſtruum, Calcareous Earth will unite alſo to Nitrous Acid, and Argill with the Vitriolic will yield Allum. 2 BERGMAN. p. 412. This method however ſeems inconvenient, as Volalkali will take up both Calx of Silver, Copper and Zinc, and ſo will Nitrous Acid.

Mr. MONNET recommends ſolution in Aqua Regia, precipitation by fixed Alkali, and digeſtion of the precipitate in Cauſtic Volalkali, and finally precipitation of the Gold from it by Pruſſite. Diſſol. Met. p. 137.

Mr. MOLLING, of JOACHIMSTHAL in BOHEMIA, torrefies the Pyrites with (one-ſixth of its weight) of Common Salt; digeſts the roaſted maſs in Marine Acid, precipitates the ſolution with fixed Alkali, Cuppels off the precipitate and thus obtains all the Gold or Silver in the Pyrites. 2 BERGB. 253.

In the dry way BERGMAN Eſſays theſe Ores by mixing two parts thereof, well waſhed roaſted and pounded, with one and a half of Litharge and three of Glaſs, covering the whole with Common Salt, and melting it in a forge in a covered crucible, he then opens the crucible, puts a nail into it, covers it, and heats it again, continuing to do ſo until the Iron is no longer attacked, the Lead is thus precipitated which contains the Gold, which is ſeparated by Cuppellation or Aqua Regia. SCHEFF. §. 239. 1. ANMERK.

2d. Gold is alſo extracted from a particular ſort of Argentiferous Copper Pyrites called in HUNGARY, GELF. This is found either maſſive or cryſtallized in Rhomboids, or other irregular quadrangular or polygon maſſes. Its contents in Gold and Silver are rich, but very unequal, much of the Gold may be ſeparated by pound-

ing and washing. Mr. MULLER concludes that Gold exists in it in a state of dispersion and not combined nor conseqently mineralized. BERGB. p. 89.

It often also exists in a greenish yellow Copper Pyrites somewhat duller than the common, and containing besides Iron, also Manganese. From this Mr. BINDHEIM extracted the Gold after torrefaction, by steeping it in water as long as any part of it was soluble therein, then drying the brown residuum he digested it in three times its weight of Aqua Regia, and after diluting and filtering the solution he poured Æther upon it, which after agitation, took up the Gold, and being burned off, left it in its Metallic form.

3d. It is found mixed with Arsenical Pyrites in the Valley of ZILLAR, near SALSBURGH. The quintal affords only 25 grains. It is separated by washing and affords a profit of about four or five hundred pounds per An.

4th. It is sometimes found in the Sulphurated Silver Ores of HUNGARY and SAXONY, and is separated, after the expulsion of the Sulphur, by Nitrous Acid, as the Gold falls to the bottom in the form of black powder.

5th. The most remarkable Ores in EUROPE affording Gold are those of NAGAYA in TRANSYLVANIA, they, properly speaking, are compounds of several Sulphurated Ores, among which Native Gold occurs either in the state of a Metallic Alloy, or more or less plentifully disseminated tho' invisible even by the help of Microscopes.

Of these Ores there are five sorts, the Antimonial, the Arsenical, the Blendose, the Manganesian, and the Sylvanitic.

The first and principal is the ANTIMONIAL. BLATTER ERZE of some, or Gold Ore of NAGAYA. Its

Its colour is bluish grey, or intermediate between that and the Iron grey.

It is found in plates of various thickness adhering to, but separable from each other, or intersecting each other in various directions, and somewhat flexible. These, some say, are crystallized in hexangular forms, but RUPRECHT denies it; between them the white Ore presently to be mentioned is often found. Lustre 3. Metallic. Transparency 0. Their fracture foliaceous inclining sometimes to the granular.

The Hardness of the plates is, 6. Their Specific Gravity, 8,919. They scrape into flakes like Plumbago, and like it stain the fingers. Soluble in Acids with effervescence.

When pulverised, three per cent of these plates are attractible by the magnet, and 21 per cent. soluble in Nitrous Acid. The solution is greenish, the residuum purplish.

100 Parts of this Ore contain about 12 of Silver and Gold, the remainder consists of Iron, Lead and Antimony all sulphurated, and Silex, the proportions are not accurately stated in the incomplete and unsatisfactory analyses that have as yet appeared.*

It is principally in this Ore, that the contenders for the Mineralization of Gold assert, that it is united to Sulphur by the mediation of the other Metallic Substances that are really Mineralized, forgetting that union with Sulphur is the most powerful means of effecting a total separation of all Metallic Substances from Gold, and that consequently Sulphur and it can never be united by their means, forgetting also that by their own theory, Metals must be somewhat calcined to unite with Sulphur, and yet allowing, that it is

* 4 Born Phy. Arbeit. p. 53. and 2 Born Phy. Arbeit. p. 85.

doubtful whether Gold exiſts in a calcined ſtate in this Ore. 2 Berg. p. 213 and 229.

Of the Arſenical Ore I can find no ſatisfactory deſcription; ſome confound it with the Sylvanitic Ore of which I ſhall preſently treat. Its colour, according to Ruprecht, is Tin white, according to Muller yellowiſh white, according to Born yellowiſh grey. Its fracture granular or foliated, often ſtriated, or fibrous. Its Specific Gravity, 10,678. It is ſo fuſible as not to bear roaſting.

When pulveriſed the Magnet attracts nearly five per cent. of it, and Nitrous Acid diſſolves 72,5 per cent. of it. The colour of the ſolution is light green, and of the reſiduum blackiſh brown.

Mild fixed Alkalis afford both with the ſolutions of this, and of the former Ore, a light yellow precipitate. By Mr. Muller's account, it contains about 25 per cent. of Auriferous Silver.

Hence Werner calls it the Silver Ore of Nagaya. According to Ruprecht, if I rightly underſtand him, it conſiſts of Gold, Silver, Arſenic, and Iron; but his account is not diſtinctly intelligible. Born tells us it contains only Antimony, Iron, and Gold. 2 Raab. p. 465. Quere does it not contain Nickel? The Matrix of both theſe Ores is a greyiſh Quartz, or Hornſtone and Silex mixed with white Calx of Manganeſe.

Of the Blendose Ores, Mr. Muller, mention two varieties, the black and the red, or the reddiſh brown, (this laſt Phoſphoreſces when ſcraped in the dark; the black does not,) whoſe external appearances do not probably differ from thoſe of the common Blendose Ores, beſides Zinc, Iron, and Sulphur, moſt of them contain Antimony alſo, and ſome Manganeſe.

The

The Specific Gravity of the **Black**, according to **Muller**, is 5,3[illegible], which exceeds the Specific Gravity of mere Blend. The Nitrous Acid dissolves 97 per cent. of it with an Hepatic smell, which common blends yield only when treated with Marine or Vitriolic Acids. It contains ,062 per cent. of Auriferous Silver. The **reddish brown** is still poorer, and seems a mixture of Blende, Manganese, Lead, and Arsenic, with a small proportion of Auriferous Silver. The **red** exposed to the Blow-pipe gives a purple tinge to Borax if Nitre be added. The black does the same, even without that addition, a sign that they contain Manganese.

The **Manganesian Ore** consists of thin Laminæ, of a grey colour, somewhat withered, inserted in a matrix of whitish Manganese. According to Mr. **Hacquet** it is very poor in Gold, But **Baron Born** tells us it contains 25 per cent. of this Metal, and is the richest of all the Ores found in that country. Yet it is so light, that it is called **Cotton Ore**. 2 Raab. p. 4[illegible]6.

The **Sylvanitic Ore** **Weisses Golderz**, of the Germans. **Aurum Graphicum**, of some, is according to **Baron Born** of a whitish colour intermediate betwixt that of Antimony and Bismuth. Lustre 3. it consists of Amorphous Plates, whose fracture is granular, like that of Steel.

Its fragments prismatic. Its Hardness from 4 to 5 brittle. Its Specific Gravity 5,723. its Matrix an Aggregate of Lithomarga and Quartz, with Pyrites interspersed. Before the Blow-pipe it decrepitates and melts like Lead. It burns with a lively brownish flame and disagreeable smell, and at last vanishes in a white smoke, leaving only a whitish earth. 2 Raab. p. 167.

Deton-

[redacted]

Detonnated with Nitre it lays bare its Gold in a Metallic State; it besides contains Arsenic and Nickel; but the greater part of it, is said to be a new semi-metal, whose Specific Gravity is 6,343. of which more particularly in the sequel. Found at FACEBAY in TRANSYLVANIA.

TO OBTAIN PURE GOLD.

The solution of Gold in Aqua Regia, should be precipitated by a solution of Vitriol of Iron, copiously diluted.

CHAP. II.

PLATINA.

This Metal, when in its moſt perfect, State exhibits the following properties.

Its colour is white, intermediate between the Tin and Silver white.

Its Luſtre 4. Hardneſs 7,5. Specific Gravity from 20,6. to 23. That of a wedge, preſented to me by ADMIRAL GRAVINA, 20,663, and that of a Bar ſent by the KING of SPAIN, to the KING of POLAND, 20,722.* Theſe variations depend on the Malleation it has undergone, and the quantity of the Flux it may have retained.

It is Malleable, ductil, and laminable as Gold, not affected by the action of the Air, ſoluble only in Aqua Regia or Oxymuriatic Acid, to which, when ſaturated, it imparts a dark red colour; precipitable therefrom by Tartarin, more difficultly by Soda; not viſibly affected by pure Pruſſian Alkali,† nor at all by a dilute ſolution of Vitriol of Iron, properties that diſtinguiſh it from Gold. Amalgamates with Quickſilver.

Nearly infuſible in the fires of our Furnaces, but yielding to the heat of powerful burning glaſſes, and alſo to that excited by pure Air.

* 1 Chym. Ann. 1790. p. 53

† Mr. Bertholet has found that when in ſolution it is in great meaſure Acidified, which accounts for many of its ſingular phænomena.

Crude

Crude or common Platina comes to us from PERU, in a Granular State, of a whitish Iron grey colour, an irregular and mostly flatted figure, and mixed with ferruginous Sand, with Quartz, in variable proportions. Hence its Specific Gravity in that State is from 6 to 11. It often contains particles of Gold or Quicksilver. When separated from the loose ferruginous and stony particles, its Specific Gravity is from 12 to 16. It is more intimately combined with Iron, and therefore still magnetic, but in some degree extensible under the hammer, and contains from one-third to one-fourth of its weight of Iron combined with it. Yet is soluble only in Aqua Regia, or Oxymuriated Acid.

It is purified from Iron by solution in about eight times its weight of Aqua Regia using heat towards the end, and precipitating the Iron by Prussian Alkali, or still better by the addition of a concentrated solution of Sal Ammoniac, which precipitates only the Platina. The precipitate, dried and heated to the highest degree, in a smith's forge for two hours, affords an agglutinated mass, susceptible of Malleation.

Spirit of Salt also strips it of much of its Iron. The Phosphoric Acid in a Glacial State, also renders it fusible in a crucible lined with Charcoal, as Mr. PELLETIER has found.

But the best method of treating it is that of Mr. JANNETTY, which I shall here describe, it not being as yet generally known.

1st. He triturates a quantity of common Platina with pure water to free it from Iron and other heterogeneities.

2d. He then mixes 1,5 pounds of it, with three of white Arsenic, and one of purified Potash, and prepares a crucible capable of containing twenty pounds.

3d.

3d. When the crucible and furnace are well heated, he throws in one-third of the mixture, and after applying a ſtrong heat a ſecond, and after heating this, the laſt portion.

4th. When the whole is thoroughly melted, he takes out the crucible, lets it cool, breaks the Regulus, which is then Magnetic, melts it a ſecond time, and if ſtill Magnetic, a third time, lets it cool, takes out the Regulus, and breaks it

5th. He then provides crucibles capable of containing Reguli, of three and a half inches diameter, puts into each one and a half pounds of the broken Regulus, with its own weight of Arſenic, and half a pound of Pot-aſh, melts it, and lets it cool in a horizontal poſition, that the Regulus may be throughout of equal thickneſs.

6th. He places theſe Reguli under a muffle, heats them until they begin to evaporate, cloſes the furnace to prevent an increaſe of heat, which would deſtroy the whole, and keeps them in that ſtate for ſix hours.

7th. He heats them in common Oil, to ſuch a degree, as to evaporate the Oil to dryneſs; and continues this operation, as long as they evaporate.

Laſtly, he inſerts them in Nitrous Acid, (probably to deſtroy the laſt remains of Arſenic) and to free them from this Acid, boils them in water; heats them to redneſs in a crucible, to prevent their abſorbing any foreign matter, being as yet ſpongy, hammers them into a denſe maſs. After which they bear heating in a naked fire, and may be hammered into bars. 14 Ann. Chym. p. 130.

Platina has no known Ore, but previous to any treatment, exiſts in a Metallic State, it is found only among Alluvial Gold Ores, amidſt ſand, in the pariſhes of NOVITA and CITARIA,

 north

CHAP. III.

OF SILVER AND ITS ORES.

In its moſt perfect ſtate, its colour is pure white.

Its Luſtre 4. Hardneſs 6,5. Specific Gravity before Malleation 10,474. After Malleation 10,510.* malleable, ductil, and laminable in a high degree, tho' inferior in that reſpect to Gold.

Soluble colourleſs in the Nitrous Acid, and in the Vitriolic Acid ſtrongly heated, but very difficultly and ſparingly in the Marine Acid, namely when exceedingly comminuted, and the Acid boiling, or in a vaporous ſtate, otherwiſe ſlowly. 2 BERGM. p. 202, 203. and BAYEN E'TAIN. 201. It yields alſo to the oxymuriatic Acid.

It is fuſible at 28 degrees of WEDGEWOOD, or rather it remains in fuſion at that degree, for it requires a higher to bring it into fuſion, and this diſtinction is applicable to the degrees of heat, requiſite for moſt Metallic Subſtances. If by means of Solution of Borax, a ſmall bit of Leaf Silver be ſtuck to the top of a ſmall Glaſs Cylinder and melted into it, it will give it a Golden Tinge. 2 BERGM. 491.

* per Briſſon

SPECIES I.

NATIVE SILVER.

By Native Silver, I underſtand Silver in its Metallic form, pure or alloyed with other Metallic Subſtances alſo in their Metallic State. Of this Species I diſtinguiſh five families.

FIRST FAMILY.

NATIVE SILVER, PURE, OR NEARLY SO.

Its colour is white, ſometimes tarniſhed bluiſh, reddiſh, browniſh, yellowiſh, ſometimes greyiſh black, colours which ariſe from the minuteſt contamination with Sulphur.

External Luſtre 4. 3. 2. 1. Metallic. Internal 2. 1.

Found in lumps, or thick or thin plates, or Spangles, Capillary, Filiform, Dendritic, Dentiform, &c. Inlaying, interſperſed, or cryſtallized in ſmall or minute Cubes or double triangular, quadrangular, hexangular pyramids, &c. variouſly heaped or implicated in each other, rarely in a ſandy form. Fracture hackly. Hardneſs 6. Malleable. Specific Gravity from 10 to 10,338. Streak brighter. It contains from 0,95 to 0,975 of Silver, the remainder often Arſenic.* It is ſoluble without any turbidity in Nitrous Acid, and does not turn blue, by the addition of Vol. alkali, which ſhews it to be free from Copper.

* 3 Lemp Magaz. 4.

SECOND FAMILY.

ALLOYED WITH GOLD.

AURIFEROUS NATIVE SILVER.

Its colour is yellowiſh white, or that of pale Braſs, more or leſs according to the proportion of Gold. Luſtre 4. 3. Seldom found in ſolitary maſſes, generally diſſeminated, or filiform and reticular, or in ſpangles. Fracture Hackly? Hardneſs 5. malleable. Specific Gravity exceeds 10,6, ſtreak brighter. Moſt of the Gold Ores of NAGAYA contain a ſtill larger proportion of Silver. An Ore from NORWAY afforded Dr. FORDYCE 72 per cent. of Silver, and 28 of Gold. Phil. Tranſac. 1776. p. 532.

THIRD FAMILY.

ALLOYED WITH COPPER.

CUPRIFEROUS NATIVE SILVER.

As the Copper is ſeldom in conſiderable proportion the external appearances are nearly the ſame as thoſe of the firſt Family, only the hardneſs is greater, and the Specific Gravity lower.

FOURTH

grey ſmoke, without the Garlic ſmell of Arſenic, and leaves a browniſh ſlagg, which imparts a green colour to Borax; but if Borax be added from the beginning, a Silver Bead may be obtained.

FIFTH FAMILY,

ARSENICATED NATIVE SILVER,

ALLOYED WITH REGULUSOF ARSENIC AND IRON.

ARSENICO MARTIAL SILVER ORE.

Arſenic Silver of Werner.

Dull white, approaching to lead-grey, ſometimes yellowiſh or ſteel-grey when tarniſhed. External Luſtre 2. Internal, 2. 3. Metallic.

Occurs in irregular lumps, rarely cryſtallized, in perfect or compreſſed ſix ſided priſms, or truncated pyramids. Fracture foliated, often curved foliated, ſometimes ſtriated.

Hardneſs from 4 to 5. Specific Gravity conſiderable, and variable.

Contains according to LASIUS from 0,12 to 0,95 of Silver, the remainder Reguline Arſenic, or Arſenicated Iron and Antimony. However KLAPROTH found in the Ore he examined, which he ſays was of the richeſt kind, only 12,75 per cent. Silver, 44,45 of Iron. 35 Arſenic, 4 reguline Antimony.*

* 1 Klaproth. 187.

When

When the proportion of Silver is confiderable it is eafily for the greater part foluble in Nitrous Acid.

Before the blow-pipe the Arfenic and Antimonial part vanifhed with their peculiar fmell and fmoke, but the Silver is more or lefs contaminated with Iron.

Found at St. ANDREASBERG in the HARTZ.*

Silver is alfo found alloyed with Quickfilver, as we fhall mention in treating of the Mercurial Ores.—I find Mr. WESTRUMB afferts this Ore to contain Antimony and not Arfenic, but his Analyfis, if publifhed, I have not yet been able to procure.

SPECIES II.

CALCIFORM SILVER ORE. *Of Widenman.*

Greyifh black, more or lefs verging to the Iron black.

Found maffive and diffeminated. Luftre 1,5. Metallic.

Fracture, fine grained Uneven paffing into the Earthy.

Hardnefs from 4. to 5. brittle. Specific Gravity confiderable.

Streak brighter, effervefces with Acids.

Melts eafily by the blow-pipe, foams with Borax; its bead blackens by expofure to the Air. By Mr. SELB's Analyfis it contains 72,5 per cent. of Silver, 12 of fixed Air, 15,5 of Calx of Antimony, with fome traces of Calx of Copper.

This Ore is for the firft time, mentioned and defcribed by Mr. WIDENMAN.

* Lafius Hartz. p. 320. Monnet Mineral. p. 281.

SPECIES

SPECIES. III.

SILVER MINERALIZED,
MOSTLY BY MARINE ACID, AND PARTLY WITH THE VITRIOLIC ACID.

FIRST FAMILY.

VITRIOLICO MURIATED,

OR CORNEOUS SILVER ORE.

Hornerz of Werner.

White, whitiſh grey, or Pearl coloured, or yellowiſh brown, or violet, or nearly black, but this laſt ſeems impure; the white ſort becomes violet by expoſure to the light, ſeldom olive green. It is found, ſeldom in compact lumps, but ſometimes in a powdery or earthy form, or diſſeminated or inlaying, oftener cryſtalized in ſmall cubes, or in accumulated flakes, or acicular, rarely capillary ſometimes piſiform, or in GEODS filled with the black Silver Ore preſently to be mentioned, or druſy, never at any conſiderable depth

External Luſtre 2. 1. Internal greaſy 2. particularly the white, or Pearl coloured.

Tranſparency in thin pieces, 2. Otherwiſe, 1.

Fracture compact, EARTHY OR UNEVEN, when ſplit into lamellæ, theſe are ſomewhat malleable and flexible, yet the yellow are brittle. It acquires a gloſs when ſcraped with a knife.

Its Hardneſs from 4 to 5. Specific Gravity 4,745 per BRISSON, and 4,804, per GELLERT.

Mr. BERGMAN with great probability deduces the origin of Vitrioliated Silver, from the wither-

ing and Acidification of the Sulphurated Silver Ores, and that of the Corneous, from an exchange of their bases that takes place between Vitriol of Silver and Common Salt,* tho' in situations in which other muriated compounds occur it may in a long course of time be formed by the gradual but immediate access of the Marine Acid.

KLAPROTH found in a lump of the amorphous sort 0,6775 of Silver, 06 Calx of Iron, 0,21 Marine Acid, 0,175 Argill, and 0025 Vitriolic Acid. Mr WOULFE found the Vitriolic Acid more abundant but the proportions are necessarily fortuitous and variable.†

Before the blow-pipe it instantly melts and gradually evaporates, but by adding an Alkali it may be reduced. NOTE the violet, and black Ore contains very little of any Acid, the Silver being nearly revived. It is generally found mixed with Iron Ochre.

This Ore disseminated in grains or streaks in a grey lime stone is what JUSTI called the ALKALINE SILVER ORE.

SECOND FAMILY.

ARGILLOMURIATED SILVER ORE.

Buttermilch erz, of the Germans.

White, or bluish grey, and internally brownish. It is found in thin crusts investing spars or quartz, of moderate consistence and brittle, feels smooth.

Lead Ochre has often been mistaken for it.

* 1 Chem. Ann. 1784, 37.

† 1 Crell. Ann. 1783, 8. Phil Transact 1776.

According

According to Mr. KLAPROTH it contains 67 per cent. of Argill, 24 of Silver, 8 Marine Acid, and ſome traces of Copper.* Treated with the blow-pipe it warps and contracts, white granules of Silver ooze from its pores With Borax it gives out its ſilvery contents, and leaves a greeniſh glaſſy bead.

SPECIES. IV.

SULPHURATED SILVER ORE.

Commonly called, Vitreous Silver Ore, Glaſſerz of Werner, or Glanzerz of others.

Dark bluiſh grey, inclining to black; when tarniſhed blue or ſteel grey, or black, or variagated.

It occurs either maſſive, or interſperſed, or inveſting, or capillary, arboreſcent, branchy, buſhy, or in thin plates indiſtinctly ſtreaked or impreſſed with pyramidal or globular forms, or cryſtalized into right angled four or ſix ſided priſms, or in cubes, partly regular, partly with their edges or corners truncated, &c. generally minute, and varioufly accumulated.

External Luſtre 2. 1. Internal 2. Metallic. Tranſparency 0.

Fracture moſtly compact, FLAT CONCHOIDAL or UNEVEN, ſometimes inclining to the FOLIATED.

Hardneſs from 4 to 5, flexible, malleable, and impreſſible.

Specific Gravity from 6,909 BRISSON, to 7,215 Gellert. Streak brighter.

* per Boſe 2 Berl. Beob. 208. Karſten Tabulariſche Uberiſcht. 25.

Fusible when heated to redness, and hence called Vitreous; in a gentler heat the Sulphur flies off.

If necessary it may be further purified by Borax. See ENGESTROM in Cronst. 300.

As by reason of its Malleability it cannot be [illegible] pulverized, it is difficultly soluble in [illegible] requiring either a very long time [illegible] heat in the latter case much [illegible] is acidified and converted into [illegible]. It is also said to be soluble in [illegible] with effervescence particularly if [illegible].*

[illegible] separated from the Sulphur by fusion [illegible] its weight of fixed Alkali.†

[illegible] contains from 70 to 77 per cent. [illegible] The Sulphur is from 12 to 15 per [illegible]

SPECIES V.

LIGHT LAMELLAR SILVER ORE.

[illegible]erz, or Zundererz of the Germans.

Sulphurated Silver intimately mixed with

Argill and Calx of Iron.

[illegible] red, or mort dorè. Lustre o. Transparency o.

It consists of thin tender Lamellæ super imposed on each other. Brittle yet in some degree [illegible]. Specific Gravity o. Stains the fingers. [illegible] fusible into a black mass.

* [illegible] Bergman. 282.

† Phil. Transact. 1779, 534.

LEH-

Lehman found it to consist of Argill, and the Sulphurated Ore, with Calx of Iron, from which it derives its reddish hue. Bindheim found in a specimen he examined Manganese and Calx of Lead. It contains from 1 to 6 per cent. of Silver.* See Leske, O. 3053.

SPECIES VI.

Sooty Silver Ore.

Silver Schwartze of Werner. Silver Mulm of others.

Black. Found in a loose powdery state, or of moderate consistence either dispersed, or investing the Ores of other Metals particularly Silver and Lead, or inclosed in geods of the Corneous Ore.

Its Lustre 0. except scraped, and then 3. Metallic. Fracture fine earthy.

Hardness 4. Stains the fingers. Nitrous Acid, dissolves it with effervescence.†

Its composition is not well known. That of Hubegrat besides Silver contains also Galena, 8 Roz. Jour. 257. That of Germany is said to contain Sulphurated Silver, Iron, Copper, and Reguline Antimony.‡ Born thinks it to be the Sulphurated Ore in a dusty form. 2 Raab. 425.

* Raab. 443.

† Lenz. 173.

‡ Lenz. 174.

SPECIES

SPECIES VII.

Antimoniated Silver Ore.

Spræterz, or Sprodes Glass, or Glanz erz of Werner, or Rosgehwachs of the Hungarians.

Iron grey inclining to the lead grey; when tarnished azure or dark blue.

It is found sometimes massive, more commonly disseminated or crystalized in six sided prisms, or tables, or in small indistinct Rhomboids, Generally small or minute and variously accumulated, or implicated in each other. External Lustre 3. 2. Metallic. Internal 2.

Fracture MINUTE CONCHOIDAL, or passing into the UNEVEN.

Hardness from 4 to 5. brittle. Specific Gravity 7,208 GELLERT. Hence it is distinguished from the Vitreous Ore, chiefly by its brittleness.

Before the blow-pipe the Sulphur and Regulus of Antimony exhale. The Silver that remains may be purified by Nitre and Borax from the Iron. 2 Chym. Ann. 1787, 11 and 12.

KLAPROTH found 100 parts of this Ore to contain 66,5 parts of Silver, 10 of Regulus of Antimony, 5 of Iron, 12 of Sulphur, 1 of Siliceous matter. The Arsenic and Copper might amount to half a grain, the remainder water and loss. 2 Chym. Ann. 1787, 12.

SPECIES VIII.

Plumbiferous Antimoniated Silver Ore.

Of this there are two families, the light and dark grey.

FIRST FAMILY.

Light grey Silver Ore.

GENUINE *Weiſs gultig of Werner.*

Light bluiſh grey.

Found maſſive or diſſeminated; not hitherto in a cryſtalline form.

Luſtre 1, 2. Metallic. Tranſparency 0.

Fracture, compact, generally EVEN, more rarely UNEVEN, and then its luſtre is greater, and it ſeems to border on the 7th. Species. Sometimes it diſcovers ſome fibres, and then ſeems paſſing into the Plumoſe Antimonial Ore. Fragments 0.

Hardneſs from 5 to 6. brittle. Specific Gravity 5; 2 as I ſuppoſe from GILLERT.

Its ſtreak is of its own colour, but brighter.

Its characters being intermediate between thoſe of the Antimoniated Ore, Species 7th. and the grey Copper Ore, it has ſometimes been miſtaken for the former, but the latter has been more frequently miſtaken for it: and often ſo called both in HUNGARY and in the HARTZ, as Mr. KARSTEN aſſures us; more eſpecially as this Copper Ore frequently contains Silver.

According

According to KLAPROTH it contains 20,4 per cent. of Silver, 48,06 of Lead, 7,88 Reguline Antimony, 2,25 Sulphur, 7 Argill, and 0,25 Silex. 1 KLAPROTH, 172.

It is probably the Ore BERGMAN calls MINERA ARGENTI ALBA, and according to him, this contains Silver and Copper united to Sulphur and Arsenic. 2 BERGM. 303 and 418.

Before the blow-pipe it in part evaporates, leaving the Silver [illegible] surrounded with yellow dust on the [illegible]. This denotes rather Reguline Antimony, and repels the idea of Copper.

SECOND FAMILY.

DARK GREY SILVER ORE.

[illegible] Weiss gultig of Klaproth.

[illegible] is Iron grey verging on black.

[illegible] Fracture Earthy, and fine grained.

[illegible] from 5 to 6. brittle. Specific Gravity [illegible] exceed 8,000.

[illegible] gives a blackish powder that sullies the [illegible].

[illegible] contains by Mr. KLAPROTH's analysis 9,25 Silver, 41 Lead, 21,5 Reguline Antimony, 1,75 [illegible] [illegible] Sulphur, 1 Argill, and 0,75 Silex per cent.

SPECIES

SPECIES. IX.

Cupriferous Sulphurated Silver Ore.

Silber glanz, of Renovantz. p. 137.

Its colour is that of Lead. Luſtre 3. Metallic.

Found in amorphous lamellar maſſes, from the ſize of the thumb to that of a fiſt.

Hardneſs from 5 to 6. brittle.

Its powder blackens the ſkin by friction, with a leaden gloſs.

Heated, it is in part exceeding fuſible, and this part reſembles Sulphurated Silver, being malleable like it, but another part is of much more difficult fuſibility, and comports itſelf as black Copper.

It communicates a blue colour, both to Volal-kali and Nitrous Acid, when diſſolved in the latter it depoſits Sulphur.

It contains from 62 to 67 per cent. of Silver and Copper; and from 38 to 33 of Sulphur. The Silver and Copper are to each other nearly in the proportion of 50 to 16 or 17.

It paſſes by various gradations into Copper Pyrites, the proportion of Silver decreaſing and that of Copper increaſing until no Silver remains, exhibiting a correſponding variation of colour, as pale blue, violet, reddiſh yellow, and finally greeniſh pale yellow.

It is found in Korbolikinsk mountains in Siberia, and was firſt deſcribed, if not diſcovered by Mr. Renovantz. This Ore, containing a large proportion, as it ſeems both of Silver and Copper without either Lead or Antimony, differs eſſentially from thoſe hitherto deſcribed.

KLAPROTH found the Ore of the HARTZ to contain 60 per cent. of Silver, 20,3 of Regulus Antimony, 11,7 of Sulphur, and 8 of Vitriolic Acid.* And in the cryſtallized of the pit FREDERIC AUGUSTUS in FRIBURG he found 62 per cent Silver, 18,5 Cryſtallized Antimony, 11 Sulphur. 8,5 Concentrated Vitriolic Acid.

That excellent Metallurgiſt Mr. SELB diſcovered another Variety of this Ore, which tho' it has hitherto occured but once, deſerves to be mentioned; its colour reſembles the foregoing, but ſometimes ſomewhat browner, ſometimes verging on the SCARLET. Its Luſtre 0, 1. Tranſparency, 0.

Fracture UNEVEN, inclining to EARTHY, its ſtreak rather Grey than Red. He found it alſo to contain Antimony with Silver.

SECOND FAMILY.

DARK RED.

Dunck'es Rothgultig of Werner.

Its colour is intermediate between the dark Cochineal Red and the lead grey, or bluiſh grey, ſometimes bordering on the Iron black, frequently without any ſhade of red.

It is found either maſſive, or inlaying, or diſſeminated, or in dendritic forms, or plates, or globules, or in thick or acicular priſms, of a ſmall or midling ſize, &c. or capillary.

External Luſtre of the Cryſtals 3. 2. 1. Internal 2. 1. bordering on the Metallic.

Tranſparency of the Cryſtallized 2. 1. of the maſſive 0. 1.

* 1 Chym. Ann. 1792, 12.

Fracture compact, ſometimes flat CONCHOIDAL, ſometimes fine or coarſe grained UNEVEN, or nearly EVEN, ſometimes approaching to the curved FOLIATED.

Hardneſs from 6, to 7. brittle. Specific Gravity from 5,56. to 5,68.

Its ſtreak Cochineal or dark crimſon Red, which diſtinguiſhes it, when the colour is ambiguous.

It has not as yet been accurately analyſed; but I ſuſpect it contains more Silver and leſs Antimony than the former Variety. I have lately ſeen an account that Mr. SELB has found it to contain Antimony and no Arſenic. Before the blow-pipe it decrepitates ſmokes and leaves a Silver bead;

SPECIES XI.

SCORIACEOUS.

Arſenicated Ferruginous Silver Ore.

Its colour is black, commonly mixed with a pale yellowiſh green apparently earthy Subſtance, found Amorphous amidſt the Silver Ores of CHALANCES in DAUPHINE.

Luſtre 2. Scoriaceous. Rifty. Hardneſs 4. Specific Gravity 2,178, when penetrated with water 2,340 if it be the Black Ore examined by BRISSON, which he ſays, has a Scoriaceous appearance.

Calcined with Charcoal under a muffle, it loſes 43 per cent. of its weight, exhaling an Arſenical ſmell, and then becomes Magnetic. It alſo affords Arſenic by diſtillation.

100 Parts

100 Parts of it contain by Mr. SCHREIBER's account 30,6 of Iron, 25, Arſenic, 11,8 of Silver, 12,5 of Water and Sulphureous Acid, 5 of Cobalt, and 5,6 of Mercury. 28 Roz. Jour. 147. Its Specific Gravity ſhould then naturally be much higher.

SPECIES. XII.

BISMUTHIC SILVER ORE.

Light bluiſh grey, becomes lighter by expoſure to the Air.

This is ſaid to have been lately diſcovered in SAXONY, found diſſeminated, ſeldom maſſive. Luſtre 2. Metallic.

Fracture fine grained, UNEVEN.

Hardneſs 5.

It melts eaſily before the blow pipe, with ſome vapor at firſt, and leaves a ſilvery bead.

SPECIES XIII.

GREENISH AND REDDISH BLACK SILVER ORE.

Ganzkothige Erz of the Germans.

This is not properly ſpeaking a diſtinct Ore, but rather a mixture of various Ores, in which Silver, both Native and Sulphurated exiſts. Yet as it is a diſtinct appearance, and is found in large quantities, particularly at CHALANCES in DAUPHINE; I think it ſhould not paſs unnoticed in a Mineralogical Treatiſe.

Its colour is ſuch as its name imports. Of moderate conſiſtence, yet not eaſily pulverizable. It conſiſts of black Cobalt, and its red

Calx,

Calx, and the green Calx of Nickel, all diſtinct and mixed with Argill, and deſtitute of Metallic Luſtre, together with Silver and ſome Mercury, which ſeems adventitious. The proportion of the ingredients differs in different ſpecimens, as may well be expected. That examined by Mr. SCHREIBER, appeared to him to contain 43 per cent. of Cobalt, 20 Arſenic, 12,75 Silver, 4,75 Mercury, 3,5 Iron, 15 of Water and Sulphureous Acid, proceeding from Sulphur acidified, in his mode of Analyſing. 28 Roz. Jour. 143.

That found in the pit of BERGMAN'S TROST in the HARTZ is compoſed nearly in the ſame manner, but the Mercury is wanting.

Subſidiary Ores, worked for Silver.

Beſides the genuine Silver Ores already mentioned, the value of this Metal makes its extraction profitable from Ores of various other Metals, as 1ſt. The grey Copper Ore, Species 3d. 5th. Family. 2d. The Plumoſe Antimonial Ore, Species 3. 3d. Galena, Species 8. of Lead Ores. 4th. Black Blende, Species 2. 3d. Family of Zinc Ores. 5th. White Arſenical Pyrites, Species 3. 6th. Yellow Martial Pyrites, particularly in HUNGARY.

Laſtly ſeveral Stones and Clays which if impregnated with any other Metal (except Gold) would attract no attention, are, when containing Silver, worked and employed, as Limeſtones, Sandſtones, Marles, &c. It is alſo found in certain Black Bitumens, tho' rarely, and in ſmall quantities.

CHAP

CHAP. IV.

COPPER AND ITS ORES.

Its colour is pale muddy red, with a ſhade of yellow.

Luſtre 3. Metallic. Malleable, flexible and ductil, tho' in theſe reſpects inferior to Silver. Hardneſs, 8. Specific Gravity, when melted and not forged 7,780, but when compreſſed 8,878. commonly. Japan Copper reaches 9,000. and is ſaid to contain Lead, or Gold. But according to BERGMAN Swediſh Copper reaches 9,3243.*

Copper is ſoluble in moſt Acids, and communicates either a green or a blue colour to them, according to the degree of its Oxygenation, as Mr. MORVEAU has long ago diſcovered; the blue indicating the leaſt, and the green the greateſt degree of Oxygenation. Alkalis, and even many Neutral Salts, act upon it.

It is precipitated from moſt Acids in its Metallic form, by a clean plate of Iron, and moſt of its ſolutions are convertible into blue by Volalkali. Neither aerated nor Cauſtic Volalkalis aſſume a blue colour from its filings in leſs than two or three hours, in the temperature of 60 degrees, whereas Calces of Copper immediately impart that tinge to them, if the Calces be not protected by Sulphur, Iron, or ſome other Metallic Subſtance from their action. It does not deflagrate with, but it ſlowly Alkalizes Nitre. It is fuſible at 27 degrees of WEDGEWOOD's Pyrometer.

* 2 Bergman 263. Tho' in his Sciagr. he lays it at 8,876, but the aſſertion in the text was made after actual experiment. Hence the beſt Swediſh Copper is the pureſt known.

SPECIES

SPECIES I.

NATIVE COPPER.

FIRST VARIETY.

Its colour is either that peculiar to Copper above mentioned, or yellowiſh, or dark brown. When tarniſhed it may be greeniſh yellow, or reddiſh with a pale green, or bluiſh ruſt, or variegated with purple, blue, red, and green, rarely white.

Luſtre 2. 1. Metallic.

It is found either maſſive, diſſeminated, or in plates, or Lamellæ, or Dentiform, Arboreſcent, ramified, botryoidal, filiform, Moſſy, or cryſtallized in cubes, generally very ſmall, or in Pyramids, &c. variouſly accumulated and implicated.

Fracture commonly HACKLY, flexible and Malleable.

Hardneſs from 6 to 7. Specific Gravity from 7,6 to 7,8. Its ſtreak brighter.

It generally contains ſome Sulphur, which depoſits during its ſolution.

SECOND VARIETY.

GRANULAR OR EARTHY, CEMENT COPPER.

Colour, reddiſh brown, ſometimes nearly black or bluiſh black.

Its conſiſtence either moderate or looſe and earthy or ſandy; when ſcraped it aſſumes a Metallic Luſtre. It proceeds from the precipitation of

of Copper by Iron, from Waters that held it in ſolution.

SPECIES II.

MINERALIZED BY A VARIABLE PROPORTION OF OXYGEN AND FIXED AIR.

Calciform Copper Ore.

Of this Species there are three Tribes, the Blue, the Green, and the Red.

FIRST TRIBE.

BLUE.

Kupfer Lazur of Werner.

Of this only one Family is as yet known, of which there are two principal Varieties.

FIRST VARIETY.

EARTHY, MOUNTAIN BLUE.

Erdiges Kupfer Laſur of Werner.

Its colour is generally Smalt Blue, ſometimes light Azure Blue.

Found maſſive, diſſeminated or inveſting, often botryoidal, or ſtalactitic, commonly of little conſiſtence and duſty, though often more indurated.

Luſtre 0.

Tranſparency 0.

Fracture, fine EARTHY, often paſſing to the EVEN or FLAT CONCHOIDAL.

Hardneſs from 3 or 4. to 6.brittle.

Its ſtreak is bluiſh; has a diſagreeable taſte, ſometimes ſtains the fingers, effervefces with, and imparts a green colour to Nitrous Acid, and a blue to Cauſtic Volalkali.

It is frequently impure and mixed with Quartz and mild Calx, &c.

Before the Blow-pipe it blackens without melting. To Borax it commonly imparts only a green colour with effervefcence. Yet ſometimes both this and the following Tribe, give with Borax a Copper Bead. Per ENGESTOM. 7 BALDING. Mag. 569

SECOND VARIETY.

STRIATED.

Azure Blue, or approaching to Smalt Blue.

Found maſſive, or interſperſed, inveſting, reniform or cryſtallized in quadrangular, priſmatic or tabular forms, generally ſmall, ofteneſt botryoidal.

External luſtre 3. 2. internal 2. glaſſy. Tranſparency of the Cryſtals 2. of the reſt 1.

Fracture fine STRIATED or RADIATED, ſometimes divergingly or ſtellularly, ſometimes approaching the FOLIATED Fragments 3.

Hardneſs from 4 to 5. brittle

Specific Gravity 3,608, BRISON. Streak blue; Effervefces with, and gives a green colour to Nitrous Acid

Mr FONTANA obtained from 576 grains of what he calls mountain blue, (moſt probably this

this variety) 18,2 of Fixed Air, mixed with purer, and 10 of Water. Hence 100 parts of it contained 31,42 of Air, mostly fixed 1,007 of Water, and 68, 73 of Copper.

According to Wallerius, it affords about 50 per cent. Copper, but he probably means the First Variety, which is generally more impure; both seem to proceed from a precipitation of Copper by Limestone.

Pelletier found 100 parts of the Azure Crystals to contain from 66 to 70 per cent. of Copper, 18 or 20 of Fixed Air, from 8 to 10 of Oxygen, and 2 of Water. 13 Ann. Chym. 65.

Before the Blow-pipe it blackens, Borax it tinges green with effervescence, and leaves on the Coal a Copper bead.

SECOND TRIBE.

GREEN.

Of this there are two Families. Malachite and mountain green, they contain more Oxygen than the former family.

FIRST FAMILY,

MALACHITE.

FIRST VARIETY.

FIBROUS.

Atlas erz, or samt erz of some.

Its colour is generally grass-green, or intermediate between that and the apple or mountain green.

Is found either maſſive, or interſperſed, or inveſting, or keniform, botryoidal, or moſſy, or cryſtalized in needles, variouſly accumulated and interwoven, or Capillary.

Luſtre Silky 1, 2. Tranſparency of the maſſive, 0. of the cryſtals 2.

Fracture divergingly and delicately FIBROUS, or STRIATED. The maſſive commonly conſiſts of diſtinct lamellar concretions. Fragments, 2.

Hardneſs from 5 to 7, brittle.

Specific Gravity, 3,571, per BRISSON.

According to Mr. FONTANA, 576 grains of the Silky Malachite of China loſt 144 grains of its weight by heat, of which 30 were Water; conſequently 100 parts of it contained 19, 4 of pure fixed Air, 5, 6. of Water, and 75 of Copper *.

It effervesces with Nitrous Acid, and gives a blue colour to volalkali. Before the Blow-pipe it decrepitates and blackens, but does not melt. To Borax it gives a greeniſh and ſomewhat yellowiſh tinge. It does not tinge flame green † as muriated Copper does.

See an entertaining account of this Ore, by REAUMUR in Mem. Par. 1723.

SECOND VARIETY.

COMPACT.

Its colour varies from the dark emerald green to the blackiſh green, often paſſing from the apple into the graſs, verdigris and mountain green

* 11 Roz. Journ. 521.

† 2 Bergm. 496.

green; sometimes presenting black ramifications.

Its external lustre 0. 1. Silky. Internal 1,5. 1. 0. Transparency 0.

Found massive, interspersed, investing, or in rounded kidney form or botryoidal masses, and lately, crystalized in quadrangular prisms surmounted with pyramids of the same form *.

Fracture compact either EVEN, UNEVEN, or perfectly CONCHOIDAL, sometimes discovering delicate fibres often presents curved lamellar distinct concretions. Fragments 2.

Hardness from 6 to 7. rarely 5. brittle. Specific Gravity, 3,641. per BRISSON. 3,653. by my trial Takes a fine polish.

Effervesces with Nitrous Acid, and gives a blue tint to Caustic Volalkali.

Doctor FORDYCE, however, mentions a light green Ore, which seems to be this, that did not effervesce †. According to Mr. FONTANA, 576 grains of it lose by heat 168, of which 35 were Water; consequently 100 parts contain 23 fixed Air, and 6 of Water. The remainder Copper as I suppose, though by the black flux he could obtain but 66 per cent. of it.

Before the Blow-pipe it decrepitates, but does not melt; to Borax it gives a green, and often a yellowish tinge.

SECOND

* 2 Chym. Ann. 1790 322.

† Phil. Transactions. 1780. p. 39.

SECOND FAMILY.

MOUNTAIN GREEN.

Kupfer grün of Werner, Chryfocolla.

COMMON MOUNTAIN GREEN.

Its colour is light verdigris green, fometimes approaching to azure blue.

Found maffive, but oftener invefting, or overlaying.

Luftre 0.

Tranfparency 0. 1.

Fracture EARTHY, often minute CONCHOIDAL, or fine grained UNEVEN. The conchoidal prefents fome Luftre.

Hardnefs from 3 to 4, brittle. Effervefces feebly with Acids *, has a difagreeable Metallic tafte.

Mr. FONTANA found 576 grains of it to lofe by heat 130, of which 24 were Water; confequently, 100 parts of it contain 18, 41 of Air, and 4, 16 of Water. It feems a mixture of Argill and Chalk, with the green Calx of Copper, and Gypfum in various proportions.

This name has often been given to cryftalized or capillary Malachite; and compact Malachite has alfo been often called mountain or copper green.

Before the Blow-pipe it prefents the fame refults as the former Families.

NOTE, CRAMER remarks that Earths are often coloured blue or green by Iron, as well as by Copper; but that thofe coloured by Iron become

* Per Hoffman, 1 Bergm. Journ. 1787. p. 395 it does not effervefce with acids; though foluble therein. Herman. p. 46 yet I found it to effervefce though feebly, and its compofition fhews it muft.

come red, after having been heated to rednefs; whereas thofe coloured by Copper, become black or dark brown. Though Calx of Iron, when flightly Oxygenated, often alfo becomes black or dark brown.

THIRD TRIBE.

RED.

Of this tribe there are two Families, the Florid red, and the Brick red.

FIRST FAMILY.

FLORID OR COCHINEAL RED.

Roth Kupfer erz of Werner. Roth Kupfer glafs, of others.

FIRST VARIETY.

COMPACT *.

Its colour is often high, often dark Cochineal red, or intermediate between the bluifh grey and Carmine red.

Found maffive, invefting, or diffeminated and perforated.

Luftre 0. 1. Semi Metallic. Tranfparency 0.

Fracture EVEN, or approaching to the minute CONCHOIDAL, fometimes EARTHY.

Hardnefs from 4 to 5. brittle.

Streak Brick red, and brighter.

Effervefces

* NOTE, In this, as in all other cafes, the term COMPACT refers to the fort of Fracture fo called. See Vol. I. p. 33.

Effervesces with Nitrous Acid, to which it gives a green tinge, and a blue to Caustic Volalkali.

SECOND VARIETY.

FOLIATED.

Leber erz. of some.

Its colour is frequently high Cochineal red, sometimes intermediate between that and the Lead grey.

Found either massive, or investing, or disseminated, often in scales, and hence called Micaceous Copper Ore, sometimes crystalized in cubes, minute and variously accumulated, or in double four sided pyramids; also stalactitic.

Lustre 2. Semi Metallic. Transpar. of the high red, crystalized 3 or 4. of the massive 0. 1.

Fracture plain, more rarely curved FOLIATED, passing to the compact, and particularly to the UNEVEN.

Hardness from 4 to 7. brittle. Streak Brick red, often somewhat brownish.

Soluble in Caustic Volalkali; and with effervescence, in Acids.

This is probably the Ore which Mr. FONTANA calls CRYSTALIZED COPPER, in contradistinction to the green and blue Ores, 576 grains of it he tells us, lost by heat 182; of which 8 were Water. Then 100 parts of it contain about 30 of Air, and 1,3 of Water.

Before the Blow-pipe it melts easily, and by Borax is reduced.

THIRD

THIRD VARIETY.

FIBROUS.

Kupfer Bluthe of Werner.

Its colour is carmine, ruby, rarely ſcarlet red. Found in ſhort capillary cryſtals or delicate flakes. Luſtre 2. 3. adamantine.

This family is commonly accompanied by Native Copper, Malachite, and brown Iron Ochre.

SECOND FAMILY.

BRICK RED.

Ziegel erz, of Werner. Hepatic Copper Ore of Born and Monnet.

In this Family, the Copper, or rather its Calx is aſſociated with a variable proportion of that of Iron.

FIRST VARIETY.

EARTHY.

Erdiges Ziegel erz of Werner. Kupper Ochre of Wallerius.

Hyacinth red, inclining more or leſs to brown or yellow.

Found maſſive, diſſeminated, or overlaying, of an Earthy ſlightly compacted conſiſtence.

Luſtre 0. Tranſparency 0. Fracture EARTHY.

Hardneſs from 3 to 5. brittle.

Gives an Earthy ſmell when breathed on.

Some ſpecimens of this variety efferveſce with with Nitrous Acid and ſome not but when heated, tho' at firſt they give a greeniſh ſolution, it ſoon becomes reddiſh, and Volalkalis give a reddiſh or yellowiſh brown precipitate, but after a while they aſſume a blue tinge. Hence it ſhould ſeem that the ferruginous ingredient is the moſt copious, and for a while protects the Cupreous part from the action of the Alkali. Accordingly the cupreous contents are in this Ore in variable proportions ſometimes 54 per cent, and ſometimes 30 per cent.

Some have thought this Ore to proceed from decompoſed Pyrites; at leaſt if it does, it retains no Sulphur, for the Specimen Leſke, O. 2269. Projected on red hot Nitre did not deflagrate nor redden in the leaſt.

SECOND VARIETY.

INDURATED.

Verharteter, or dichets Ziegel Kupfer erz. of Werner.

Hyacinth red, or reddiſh brown, or browniſh red, or dark nut brown.

Found maſſive or diſſeminated.

Luſtre 0, 1, 2. The dark brown, 2. Tranſparency 0.

Fracture CONCHOIDAL, groſs flat or minute. This laſt has moſt luſtre

Before the blow-pipe it blackens, and gives Borax a brown greeniſh tinge.

All the ſpecimens I tried efferveſced with with Nitrous Acid, but with ſome, Cauſtic Volalkali gave reddiſh and yellowiſh brown precipitates, tho' after ſome time the Alkali aſſumed a blue

a blue colour Others immediately gave a green colour to the Nitrous Acid, and a blue to Vol-alkalis. Hence I judge this variety alſo, contains a variable proportion of Calx of Iron. And accordingly MONNET. 319. Tells us it contains from 15 to 30 per cent of Copper. And BORN. 2 RAAB. 347. reduces its Cupreous contents to 10 or 12 per cent. But RENOVANTZ makes them amount to 50 per cent. Some think, and I believe juſtly, that both theſe Varieties conſiſt of the red Copper Ore of the former family with brown Iron Ochre.

Sometimes this Ore is mixed with Bitumen, it is then that its colour is BROWNISH BLACK, or dark yellowiſh brown and is called PECH ERZ or pitch Ore.* Its fracture flat CONCHOIDAL, or EVEN.† .

Its hardneſs from 6 to 7. Its Specific Gravity 3,5-2. GELLERT.

I ſhould expect it to detonate or deflagrate with Nitre.

It affords according to ſome from 7 to 8 per cent. of Copper, others ſay from 20 to 50. Some call by this name a dark brown Ironſtone impregnated with calces of Copper. Somewhat reſembling Hæmatites. Luſtre 1,5 or 2. Its fracture generally flat conchoidal.

Note the Earthy Ores, unleſs very rich are are difficultly reducible by the blow-pipe, for their peculiar management, ſee ENGESTROM in Cronſt. 404.

* Karſten in Leſke. 415.

† 1 Chym. Ann 1794, 257.

SPECIES. III.

MINERALIZED BY SULPHUR, *with various associated Metals.*

Of this I distinguish five families, the PYRITOUS, the PURPLE, the VITREOUS, the BLACK and the GREY COPPER ORE.

FIRST FAMILY.

Combined with a large proportion of Sulphur and more than its own weight of Iron.

YELLOW COPPER ORE.

Copper Pyrites. *Kupper kies of Werner.*

Its genuine colour is light yellow, sometimes verging on the steel grey, or greenish yellow, when tarnished by exposure to the air it is often Gold yellow, or variegated with blue, green, or red, singly or collectively.

It is found either massive, investing or disseminated, or specular, botryoidal, or Reniform, or branchy, or crystalized in triangular, or double quadrangular Pyramids, or six sided plates, the Crystals small or minute.

Its External Lustre. 3, 2, 4.

Internal. 2, 1. Metallic.

Transparency 0.

Fracture EVEN, UNEVEN or imperfectly and minutely CONCHOIDAL, or passing into the FOLIATED.

Hardness

Hardneſs from 6 to 7. rarely 9. brittle. Specific Gravity 4,314 BRISSON, or 4,16 GELLERT, or 4,080 of a greeniſh one from LORRAIN by my trial.

Copper Pyrites projected on burning coals, and during torrefaction, gives a green colour to flame*.

It deflagrates, but does not detonate with Nitre; at leaſt this is true of the greeniſh yellow.

It does not effloreſce by expoſure to air and moiſture. Hence we ſee it differs from Martial Pyrites both in hardneſs, and by the abſence of cubic or rhomboidal forms; and further, it does not efferveſce with Nitrous Acid, (nor is ſoluble but in a ſtrong Acid, aſſiſted by heat,) as Martial Pyrites does. Cauſtic Vol Alkali precipitates a yellowiſh and reddiſh brown matter from this ſolution, and does not immediately become blue with the Ore, which ſhews the Copper is in a reguline ſtate; but after ſome time it aſſumes a blue tinge. The yellow and yellowiſh green Pyrites are ſaid to be the richeſt in Copper; ſo alſo are the ſofter kinds. The harder it is the more Iron it contains.

Its Cupreous contents vary from 4 to 20, ſome ſay 30 per cent. In general the ferruginous part far exceeds the cupreous. The Pyrites that contain moſt Sulphur are leaſt alterable by expoſure to the air.

Before the blow-pipe it decrepitates, gives a greeniſh ſulphureous ſmoke, and melts into a black maſs, which, to Borax imparts a green tinge, and ſometimes when not mixed with too much Stony matter or Iron, is reduced. ENGESTR. in CRONST. 305.

* 2 Bergm. 498.

SCHEFFER

SCHEFFER imitates this Pyrites by ſtratifying Iron and Copper-Plates in a crucible, to which another whoſe bottom is knocked out, is luted, adding ſulphur to them when heated to redneſs, and then melting them. VORLESSUNG. § 296.

The tranſitions of this Ore into the Cupriferous Silver Ore, deſerve attention.

SECOND FAMILY.

PURPLE.

Bunt Kuuper ertz of Werner. Kupper lazur of ſome.*

Combined with a ſmall proportion of Sulphur, and leſs than its own weight of Iron.

Its colour is purple, ſometimes nearly blue, or greeniſh blue; ſometimes nearly Copper red, or inclining to tombac brown, or to pale yellow, or reſembling the tints of hardened Steel. Its internal colour is reddiſh yellow, or bluiſh red, but quickly alters by expoſure to the air, becoming duller, bluer, or redder.

Found maſſive, diſſeminated, overlaying, or inveſting, or in plates very rarely chryſtalized, and then in an octohædral form, ſome ſay alſo in quadrangular priſms with diæhœdral pyramids.†

Luſtre 3. 4. 2. Metallic.

Tranſparency 0.

* Though *Bunt* ſignifies variegated, yet I chuſe to call it purple, as this is the colour that chiefly prevails in this Family, and leſt it ſhould be confounded with the Pyrites variegated like a pidgeon's neck or peacock's tail.

† Herm. Naturgeſch. des Kupfer. p 70.

Fracture

Fracture minute or perfectly CONCHODIAL, or inclining to the EVEN, or UNEVEN.

Hardneſs from 6 to 7. brittle. Specific Gravity of the ſpecimen 2164. LESKE O. was 4,956. of another which I had from LORRAINE 4,983. by my trial.

Streak reddiſh, and brighter.

Effervesces with Nitrous Acid imparting to it a green colour; does not immediately give a blue tinge to Cauſtic Vol Alkali.

It deflagrates with Nitre. Its Specific Gravity and effervefcence with Acids, prevent all poſſibility of miſtaking it for the tarniſhed Ores of the former Family.

It affords from 40 to 60 per cent of Copper.

Before the blow-pipe it melts readily, without ſmoke, vapour,, or ſmell. but is not reduced. To Borax it gives a bright green tinge.

It is moſt frequently mixed with Copper Pyrites, or Vitreous Copper Ore.

THIRD FAMILY.

Combined with an inconſiderable proportion of Sulphur, and ſome proportion of Iron.

BLACK COPPER ORE.

Kupfer Schwartze of Werner.

Its colour is browniſh black, or very dark brown, with ſome ſhade of Red.

Found in the Rifts of Copper Pyrites, or of the grey Copper Ore, in lumps or inveſting.

Luſtre 0

Texture

Texture loose, friable and dusty; slightly staining the fingers and heavy.

It dissolves with effervescence in Nitrous Acid, imparting to it a green colour.*

Before the blow-pipe it melts with a sulphurous smell into a slagg which imparts a green colour to Borax. It is with some hesitation I assign the constitution of this Ore, having no specimen on which to make any trial.

FOURTH FAMILY.

MINERALIZED BY SULPHUR, WITH LITTLE OR NO IRON.

VITREOUS COPPER ORE.

Kupfer glass of Werner.

Of this, WERNER distinguishes two Varieties; the Compact and the Foliated.

FIRST VARIETY.

COMPACT.

Bluish grey, or steel grey; sometimes tarnished blue like polished steel.

Found massive, disseminated, investing, stalactitic, capillary, or chrystalized in six sided small prisms, or quadrangular pyramids, joined base to base. &c.

Lustre 3. 2. rarely 1. Metallic.

Fracture minute, CONCHOIDAL or UNEVEN.

* *See Note, p. 27.*

Fragment

Fragments 3. Streak brighter grey. Hardneſs from 4 to 7.

It is ſaid to be ſomewhat malleable.* Specific Gravity per GELLERT 5,565. Of a ſpecimen I had from CORNWALL, whoſe hardneſs was 6. and its fracture minute CONCHOIDAL, 5,452. Of another from HUNGARY whoſe fracture was UNEVEN, and its colour Steel grey, 4,129.

Said to be eaſily fuſible, tinges Borax green. Deflagrates with Nitre.

The CORNISH Ore effervеſces with Nitrous Acid, the ſolution is green. It alſo immediately tinges Volalkali blue. The HUNGARIAN Ore alſo effervеſced with, and imparted a green colour to Nitrous Acid, but was not ſoon acted on by the Volalkali. Hence I take the latter (as well as by reaſon of its lower Specific Gravity) to contain more Sulphur.

This ſeems to be the grey Corniſh Ore analyſed by KLAPROTH, 1 Berl. Beob. 181. Out of which he procured about 56 per cent. of copper. It loſt not quite 6 per cent. by calcination, and though the true contents of Sulphur cannot thus be known, yet it is plain it contained but little of it.

SCHEFFER imitated this Ore by projecting Sulphur on thin plates of Copper heated to redneſs, and then fuſing the maſs, § 295. I alſo exactly imitated it by melting Copper with one-fourth of its weight of Sulphur.

The Vitreous Copper Ores of SIBERIA contain a conſiderable quantity of Silver, and ſometimes alſo Gold. To this family may be annexed the ſmall round flatted maſſes with a central protuberance, found in HESSED, reſembling petrifactions.

* Herman. p. 68.

SECOND VARIETY,

FOLIATED.

Its colour ſeems to be the ſame as that of the firſt, but darker and inclining to black:

Its Hardneſs from 4 to 5. Its Luſtre 2. Its Fracture imperfectly FOLIATED, in other reſpects they agree. It is frequently accompanied with red or brown Iron Ochre, or Malachite.

Expoſed to the blow-pipe both Varieties eaſily melt, and while in fuſion exhibit a green pearl, which on cooling is covered with a brown coat, but to Borax both communicate a green colour.

FIFTH FAMILY,

MINERALIZED BY SULPHUR, WITH REGULINE ANTIMONY, AND CASUALLY ASSOCIATED WITH LEAD AND SILVER.

GREY COPPER ORE.

Fahlerz of Werner. Mine de Cuivre Vitreuſe dure, of Monnet.*

Steel grey, approaching ſometimes to the Lead grey, and ſometimes to the Iron black, aſſuming when tarniſhed, the variegated colours of hardened Steel.

* Some have improperly called this FALLOW Copper Ore, but FALLOW denotes in Engliſh a pale reddiſh yellow, like that of a half burnt brick.

Found

Found massive, disseminated, investing, dull, or specular, or crystallized in triangular Pyramids (seldom perfect) or triangular Tables, or in six sided prism, small or minute

External Lustre 3. 2. 4. Internal 2. 3. 1. 4. Metallic; has much they appearance of a grey Metallic slag Transparency 0.

Fracture, compact, generally UNEVEN coarse or fine grained, sometimes passing into the CONCHOIDAL, and thro' that into the EVEN: when CONCHOIDAL its Lustre is greatest, when EVEN least.

Hardness 7 or 8. exceeding brittle. The Specific Gravity, of the specimen LESKE O, 2222, from SALZBURG, cleared as much as possible from sandstone but not fully free from it 3,782. If fully free from it, I make no doubt but it would reach 4,00. It gives a dark grey, and sometimes a brownish red streak.

It deflagrates with Nitre.

Before the blow-pipe it crackles, but at last particularly if assisted by Borax melts.* The bead gives a white smoke without any particular smell, does not unite with Borax, but tinges it yellowish or brownish red. See ENGESTROM in CRONSTED, p. 304.

It is almost always accompanied with Copper Pyrites.

It differs from the LIGHT GREY SILVER ORE, as the Silver Ore has less Lustre, is never specular nor crystallized, its Fracture more generally EVEN, and not Conchoidal, and its Hardness not so great, and its Specific Gravity higher.

It often contains Lead and always Reguline Antimony as well as Copper and Sulphur, and sometimes Silver.

* 2 Bergman, 497.

There is a Variety however of this Ore found at KREMNITZ in HUNGARY which contains no Lead, but only Reguline Antimony, Copper, Silver, and a small proportion of Iron.

Hence KLAPROTH chuses to count it among the Silver Ores, judging Lead to be essential to the grey Copper Ore, and calls it GRAUGULTIG. Yet as in its external Characters, Colour, Lustre and Fracture it approaches, as he says, nearer to the grey Copper Ore (FAHLERZ) than to any Silver Ore, and as it contains much more Copper than Silver, I think it should rather be aggregated to the Ores of the former, than those of the latter. In effect Chevalier NAPION, in the Memoirs of TURIN for 1790, mentions one found in the Valley of LANZO in Piedmont, whose characters by his description exactly agree with those of this grey Copper Ore, in which no Lead exists but only, by his Analysis, 29,4 per cent. of Copper, 37 of Reguline Antimony, 12 of Iron, 4,5 Arsenic, 0,62 Silver, 10,6 Sulphur, and 1 of Argill.

Mr. KLAPROTH analysed three Ores sent to him under the denomination of FAHLERZ. In that from ANDREASBERG in the HARTZ, he found 34 per cent. of Lead, 16 Copper, 16 Regulus of Antimony, 13,75 Iron, 10 Sulphur, 2,25 Silver, and 2,5 of Silex. In that from KREMNITZ in HUNGARY, 34 per cent. Regulus of Antimony, 31,36 Copper, 14,77 Silver, 3,3 Iron, 11,5 Sulphur, and 5 of Argill.

In that from CORNWALL, 49 per cent. of Lead, 21 Reg. of Antimony, 13,5 Copper, 1,5 Iron, 7 Sulphur, and 0,5 of Silex. This last may certainly be reckoned a Lead Ore.

It were to be wished that the external appearances of each had been given. KARSTEN tells us, that the grey Ore from the HARTZ is the real

real FAHLERZ.* KLAPROTH remarks that Lead, which otherwife is perfectly foluble in Nitrous Acid, is protected from it by the Reg. of Antimony.† It fhould be obferved that Reg. of Antimony is found in all of them, and moft probably the great brittlenefs of this Ore proceeds from it. It fhould be alfo obferved that Ores cannot be always denominated from the moft abundant ingredient as fome fyftematic writers would have us affume, but rather from that which is moft profitably extracted from them. For to imagine any thing like perfect uniformity in the compofition of Metallic Ores in general is perfectly vifionary.

A Detail of Mr. KLAPROTH's Analyfis is eagerly expected.

SPECIES IV.

MINERALIZED BY THE MURIATIC ACID,

Green Sand of Peru.

Its colour is Grafs Green; of the confiftence of Sand, and when infpected thro' a ftrong lens, feems a mixture of tranfparent green particles with Quartz.

It is foluble in the Nitrous Acid, and the folution is blue, but ftill more readily in the Marine Acid, and the folution is green, but it effervefces with neither. Volalkalis alfo diffolve moft of the Cupreous matter. Thrown on burning coals it gives a green and blue colour to the flame,

* 1 Bergm. Jour. 1790, 378.

† 1 Chym. Ann. 1790, 295.

which

which diſtinguiſhes Muriated Copper from other green Calces, or Sand tinged by them.

Diſtilled with Vitriolic Acid in a Retort, to which a receiver containing a ſolution of Soda was adapted, the Soda was found converted into Common Salt, which was ſcientifically ſeparated from the Glauber, at the ſame time produced, by Mr. BERTHOLLET. Mem. Par. 1786. 462. and 475.

It contains about 56 per cent. of Copper, 11 of Marine Acid, 1 of fixed Air, 12 of Water, and 13 of Silex. The 7 remaining grains were pure Air, ariſing from the calcined ſtate of the Copper.

Green cupreous ſandy Ores are alſo found in SWEDEN, GERMANY, and SIBERIA, but whether of this Species is as yet uncertain. HERMAN, p. 54.

Muriated Copper has alſo been found by Mr. BERGMAN in the Green Mica deſcribed by WERNER, in his edition of Cronſted, p. 217, and which KLAPROTH diſcovered to be an Ore of Uranite. It may be diſcovered by ſolution in Nitrous Acid, and a Solution of Silver. See 1 Noſe. 201 and 202.

SPECIES V.

MINERALIZED BY THE ARSENICAL ACID.

Under this head I place three ſorts of Copper Ore, whoſe relation to each other I do not venture poſitively to aſſert, as in the two laſt the Arſenical principle has not as yet been demonſtrated.

OLIVE

OLIVE COPPER ORE.

Oliven erz of Werner.

Its colour is olive green, paſſing into the leek or darker green, ſeldom riſing to Verdigris or a clearer green.

Found for the moſt part chryſtalized in compreſſed hexahædral priſms, accumulated, diverging, capillary or moſſy, ſometimes into cubic or quadrangular tables.

Luſtre 3. 2. glaſſy. Tranſparency 4. 3. 2.

Fracture FLAT CONCHOIDAL ſometimes verging on the FOLIATED, or ſmall grained UNEVEN.

Hardneſs from 4 to 7. Streak ſometimes ſtraw coloured, ſometimes olive green.*

KLAPROTH found the priſmatic Cryſtals to conſiſt of Copper Mineralized by the Arſenical Acid, and the Cubic to contain beſides a little Iron.† For with the blow-pipe they gave out an Arſenical ſmell, and on the addition of Borax afforded Copper, and the Cubic both Copper and Iron, leaving a grey bead.

EARTHY IRON SHOT MOUNTAIN GREEN.

Erdiges eiſen Schuſſig Kupfer grun of Werner.

Its colour is clear olive green, ſometimes approaching to the Canary green.

Found maſſive or diſſeminated.

* Bergman's Journ 1792. 232.

† 1 Berl. Beob. 160.

Luſtre

Lustre 0. Transparency 0. Fracture EARTHY. Hardness 4 brittle.

Some think this a mixture of Mountain green, and Iron Ochre. Its olive colour inclines me to suspect the Arsenical Acid.

GLASSY IRON SHOT MOUNTAIN GREEN.

Schlackiger Kupfer grun of Werner.

Dark olive green, sometimes approaching to the leek green.

It is found massive and disseminated.

Lustre 2. Transparency 0. Fracture flat or minute CONCHOIDAL.

Hardness 5, 6. brittle. Streak olive green.

SPECIES VI.

MINERALIZED BY ARSENIC.

WHITE COPPER ORE.

Weiss Kupfer erz of Werner.

Its colour is Silvery white, yet approaching to pale Brass yellow, or with a shade of green, more rarely to Tin white.*

Found massive or interspersed.

Lustre Metallic 2. Fracture compact UNEVEN, small and fine grained; sometimes seemingly foliated. Hardness from 8 to 9. brittle.† Specific Gravity considerable.

* Bergman's Journ 1789, 2037. Herman. p 75.

† Ibid.

It

It is said to be one of the rarest Copper Ores, and with Copper to contain Arsenic, though according to HOFFMAN it does not give an Arsenical smell when struck with Steel. The grey Copper Ore and Mispickel are frequently taken for it.

Before the blow-pipe it gives out a white Arsenical smoke, and melts into a greyish black slag. WIDENMAN.

According to HENCKEL it contains 40 per cent. of Copper with Arsenic and Iron.

Mineralogists have distinguished various Cupriferous compounds by other appellations, which, however, contain no other Mineralization than the Ores already mentioned, and are reducible to them. Thus Slaty Copper Ore, or CUPRIFEROUS MARLITE, *Kupfer Schiefer* is nothing more than Bituminous Marlite accidentally impregnated with Copper Pyrites, or Purple, or Vitreous Copper Ore, &c.

HEPATIC COPPER ORE, CUPPER LEBER ERZ, LEBER SLAG is a yellowish brown Iron stone impregnated partly with native Copper, partly with brick-red Copper Ore, or the black Copper Ore.

PITCH COPPER ORE I have already mentioned.

COMBUSTIBLE COPPER ORE, *Cupfer brand erz*, is only bituminous shale or coal, impregnated with Copper.

BRASS ORE, is only a mixture of Copper Pyrites and Blende.

BELL METAL ORE, is a mixture of Copper and Tin Pyrites.

LAPIS ARMENUS, is Chalk or Gypsum impregnated with the blue Calx of Copper.

TURQUOISE is Ivory tinged by the blue Calx of Copper. Its Specific Gravity from 2,5 to 2,908. It loses its colour when heated. The Copper may be extracted from it by distilled Vinegar.

CHAP. V.

IRON.

The colour of Bar Iron, when fresh broken, is pale, somewhat bluish grey.

Lustre 3. Transparency 0. Fracture Hackly, or Uneven, and fine grained. Malleable.

Hardness from 8 to 9, of Steel, 11. Specific Gravity of Cast Iron from 7,2 to 7,6. of Bar Iron from 7,6 to 7,8. of Steel from 7,78 to 7,84 *. The heaviest of each sort is the best. The Specific Gravity of Calces of Iron, RINMAN found to be 4,81.† when the Iron had gained in absolute weight 32 per cent. or more. When it gains less, its Specific Gravity must be higher, and when so low, I imagine, it contained much Water.

When after Calcination it contains less than 24 per cent. or Oxygen, it is strongly attractible by the magnet, and more or less soluble in Nitrous Acid, inversely as its proportion of Oxygen. If it contains from 21 to 28 per cent. it is weakly magnetic and insoluble in that Acid without particular management. If it contains above 30 per cent it no longer obeys the magnet in the usual manner of presenting it, nor is it acted upon by the Nitrous Acid. Calces of Iron give a pale green glass, with microcosmic salt. 3 Berl. Beob. 342. And also with Borax, but so much the more inclining to yellow as they are more Oxygenated. 2 BERGM. 498. The best Iron is that which gains most weight by Calcination, or gives out most Inflammable Air by solution in Vitriolic

* Bergman sets the Specific Gravity of Iron at 8,3678.
† Rinman. §. 64

Acid, for it contains moſt parts thoroughly metallized.

SPECIES I.

NATIVE IRON.

The exiſtence of Native Iron, ſeems now placed beyond the reach of doubt. The teſtimony of MARGRAF, tranſmitted to us by LEHMAN, with reſpect to that found at EIBENSTOCK in SAXONY, ſeems to me ſufficient, that Specimen LEHMAN aſſures us was both Malleable and ductil, conſequently in the ſtate of BAR IRON. It has alſo been lately found in the ſame ſtate in the Mountain of GRAND GILBERT, in Upper DAUPHINE', by Mr. GAULTIER DES COTTES, as Mr. SCHREIBER aſſures us. 41 Roz. 7.

We have alſo had another late and indubitable inſtance of the exiſtence of Native Iron, on the plains of OTUMPA in PERU of ſeveral Tun weight, on which the impreſſions of men's hands, and of the claws of birds had been found by DON RUBIN DE CELIS*. he imagines it to have been produced by fuſion; if it were, it is ſtill the product of Nature, and not of Art. Yet I muſt own the impreſſions made on it ſeem repugnant with the ſuppoſition of this mode of production, as they muſt have been made while the Iron was as yet ſoft. And if ſoftened by heat, what Animal could then preſs it? It ſeems much more natural to ſuppoſe that it originally conſiſted of detached particles of Native Iron collected in the moiſt way, and hardened by ſubſequent deſiccation as frequently happens to heaps of fiery Cinders near forges, after thoſe heaps

* Philos Tranſact. 1788. 38, &c.

heaps had been long expofed to the Air, the Earthy Matter which originally furrounded and formed the Pit in which it was collected, being by fubfequent inundations wafhed away. What Don Celis calls afhes, by which he fays it is furrounded, is more probably nothing more than a loofe white clay.

The enormous Mafs of Iron found in Siberia, by Pallas, is alfo plainly a natural production, and formed by depofition in the moift way, for no fuch Mafs has hitherto been feen in the neighbourhood of a Volcano, and if there had, it would be infufficient to lead the mind to any volcanic caufe in this cafe, as this Mafs is found on the fummit of a mountain, in which, nor in its vicinity for fome hundred of miles, no trace of a Volcano can be difcovered. It is Malleable when cold, and produces Inflammable Air, when treated with Acids, which prove it not to be in a calcined ftate. The fubftance found in it, which was thought to be Glafs, is now known to be Cryfolite.

SPECIES II.

IRON IN A CALCINED STATE,

MINERALIZED BY PURE AIR.

Calces of Iron are fufceptible of three ftates, according to the proportion of Oxygen they may contain, as already mentioned, thofe comprehended under each of thefe I call Tribes, and as thefe tribes are themfelves fubject to various external modifications by union or mixture with other fubftance hence I diftinguifh them into different Families.

Of

Of these the Black, greyish black, and bluish grey are most Magnetic, then the Violet, then the Brownish red; the clear red, and yellow least, or not at all.

A slight proportion of Oxygen does not prevent Iron from being magnetic; on the contrary the Magnet itself consists of Oxygenated Iron. Nor does a small proportion of water or Sulphur, but a large proportion of either of these, or of Manganese, Regulus of Antimony, or Arsenic, weaken or destroy this correspondence. According to SCHAEFFER above $\frac{1}{12}$ of its weight of Arsenic destroys its magnetism.*

FIRST TRIBE.

Mineralized by, from 15 to 24 per cent. of Oxygen.

FIRST FAMILY.

COMMON MAGNETIC IRON STONE.

Gemeiner Magnetischer Eisenstein, of Werner.

Dark Iron or bluish grey, inclining to steel grey, sometimes to the Cochineal red in its fresh fracture, but its surface is generally brownish black.

Found massive, or disseminated, foliaceous globular, or crystallized in four sided prisms, or double quadrangular pyramids joined base to base, and thus forming Octohædrons, or in short Hexahædral prisms terminated with three quadrangular faces, &c. or in cubes.

External Lustre, 2. of the Crystallized; Internal 2. Of the massive 1 or 1,5 Metallic. Transparency, 0.

* Schæffer § 300

Fracture,

Fracture, generally fine grained UNEVEN or intermediate between that and the fine grained CONCHOIDAL, sometimes plain but imperfectly or curved foliated, it presents minute fine grained distinct concretions.

Hardness from 9 to 10 brittle. Specific Gravity from 4,243 to 4,678 per BRISSON, or 4,683 GELLERT. I found that of the specimen Leske O. 2473 which was the purest, to be 4,688. and of the specimen 2467 to be 4,094. But that of the specimen 2470 was only 3 527; and that of the specimen 2460 only 3,954; these were evidently impure.

It gives a blackish grey streak, or brownish black, and brighter.

Most of the SWEDISH Ores are of this Family; all are Magnetic, and rather gain than lose weight by calcination.*

The Magnet itself belongs to this Family, and differs from other Ores only in being ACTIVELY as they are passively Magnetic; it commonly betrays some tendency to the Octohædral form.

Mr. RINMAN observes, that all the Magnetic Ores give red shot Iron, but that this is easily remedied by a second fusion. It appears to me that the cause of this quality is deducible from the quantity of Oxygen, which Iron, when too quickly fused, often retains; Calces never thoroughly unite with substances in their fully Metallic state, hence when Iron is much dilated, as it is in a red or white heat, the points of contact are too few, and a division or fracture necessarily takes place. Sulphur in ever so small a proportion, Argill, or any other foreign ingredient produces the same effect.

* Rinman § 39. 4.

This

This Ore is ſaid to afford, when in its greateſt purity, 90 per cent of Iron.* This muſt appear ſurpriſing, as we have ſtated it to contain from 15 to 22 per cent of pure Air, which it muſt loſe in the act of Metallization: this loſs it is true, may be more than compenſated by the quantity of carbonic matter it takes up, but this high proportion of Iron is alſo incompatible with the Specific Gravity above ſtated. Mr. Lenz ſtates its contents more juſtly at from 50 to 80 per cent of Iron.

Before the blow-pipe it burns browner, and to Borax gives a dark green colour.

The Mountain Pumachanche in Peru conſiſts intirely of Magnet. Hiſt. Acad. Paris, 1779, 49.

SECOND FAMILY.

FIBROUS.

Faſeriger Magnetiſcher Eiſen ſtein of Karſten.

Its colour is intermediate between the Steel grey and bluiſh grey.

It was found maſſive mixed with ferruginous and calcareous particles.

Luſtre 1. common. Tranſparency 0.

Fracture partly paralell, partly divergingly fibrous, in the groſs inclining to ſlaty, preſenting partly fine and partly coarſe grained diſtinct concretions.

Hardneſs 6. brittle. Specific Gravity 3,275 by my trial.

Gives a bluiſh black ſtreak.

* 1 Bergman's Journ. 1791. 179.

Vigorouſly

Vigorouſly attracts filings of Iron; as this Ore evidently contains ſtony matter, is not this power owing to the FIBROUS TEXTURE OF IRON, NEARLY IN A METALLIC STATE?

The only ſpecimen now known is that in LESKE O. 2461. diſcovered and deſcribed by KARSTEN.

THIRD FAMILY.

MAGNETIC SAND.

Magnetiſcher Eiſen Sand of Werner.

Its colour is black, or greyiſh black from a mixture of Siliceous, Gypſeous, or Calcareous particles. It conſiſts of grains, ſome fine, ſome coarſe, and frequently of a ſtrong or weak Metallic Luſtre; its Fracture CONCHOIDAL very hard, and magnetic.

Found in ITALY, VIRGINIA, ST. DOMINGO, and the EAST INDIES. The ſands hitherto examined were inſoluble in Acids, without particular management, both before and after calcination.*

The Specific Gravity of that of VIRGINIA is 4,600. That of ST. DOMINGO treated with Tartarin before the blow-pipe melts with efferveſcence into a black glaſs, and with microcoſmic Salt an opake greeniſh Enamel, hence I take it to contain Silex.

* 2 Phil. Tranſ. Abridg. 556.

SECOND TRIBE.

Mineralized by from 24 to 30 per cent. of Oxygen.

This Tribe is very ſlightly or not at all Magnetic, unleſs finely pulverized.

FIRST FAMILY.

Specular Iron Ore.

Gemeiner Eiſen Glanz of Werner.

Light or dark ſteel-grey, or if tarniſhed, azure blue, or gold yellow, or beautifully variegated blue and red.

Found maſſive or diſſeminated, or cryſtallized, in cubes, either perfect or with their ſolid angles or edges truncated, or in octohædrons, or double three ſided pyramids, or tabular, in flat hexahædral maſſes regularly accumulated or implicated, or lenticular in thin ſharp plates, often cellularly diſpoſed.

Luſtre, 3, 4. Metallic. Tranſparency, 0.

Fracture, fine or coarſe grained UNEVEN, or minute CONCHOIDAL, preſenting granular, columnar, plain or curved Lamellar diſtinct concretions, ſometimes inclining to the broad STRIATED, very rarely SLATY.

Hardneſs from 9 to 10. Specific Gravity from 4,939 to 5,218, BRISSON, or 5,158, GELLERT.

I found

I found that of the ſpecimen Leske, O. 2512, to be 5,139. But that of the ſpecimen O. 2501. from ſome vacuities ariſing from its ſtructure was only 4,793.

Its ſtreak is greyiſh red, or dark red, ſeldom black.

All thoſe of Leske, which I examined, were ſlightly magnetic, and redden when heated.

Nitrous Acid does not affect either this or any of the Families of this or the next Tribe. But Marine Acid, eſpecially when heated, attacks it, and acquires a light or deep Orange yellow colour, according to the proportion it has diſſolved. Its difficult ſolubility proceeds in great meaſure from its aggregative affinity.

The high Specific Gravity of this Ore, is very remarkable, and ſhews its particles muſt be very intimately united.

The blow-pipe has but little effect on it; to Borax it gives an obſcure yellow tinge.

SECOND FAMILY.

Brown Hæmatites.

Brauner Glaſskopf of Werner.

Externally brown or black, or bluiſh black, ſeldom of a middle colour between the yellow and nut brown; ſometimes Irideſcently variegated yellow and red. Internally nut brown. Seldom Steel grey with black arborizations.

Found maſſive, inveſting or incumbent, or in nodules of various ſizes, or globular, botryoidal, arboreſcent, tabular, cellular, ſtalactitic, cauliform, or cryſtallized in hollow ſecondary ſharp

 angled

angled hexahædral Pyramids, or in Pentagonal Pyramids.*

External Luſtre 2. 3. Internal 2. 1. Common, but the variegated looks Metallic. Tranſparency 0. Fracture delicately fibrous, ſtreight curved or diverging, often preſenting fine or coarſe grained curved lamellar diſtinct concretions turned outwards. Fragments 3.

Hardneſs from 8 to 10 brittle. Specific Gravity 3,7 9. GELLERT. That of the ſpecimen LESKE O. 2611, was by my trial 3,951.

Streak, reddiſh or yellowiſh brown. Its powder alſo red. Not Magnetic, until calcined. Before the blow-pipe it blackens, and gives to Borax a dark yellow tint, with ſome effervefcence. This Ore has not as yet been Analyſed, but from the properties attributed to it by a very intelligent obſerver Mr. De La PEYROUSE, I am inclined to think it contains a large proportion of calx of Mangeneſe.† It alſo contains a notable proportion of Argill.‡ And hence its low Specific Gravity and the ſmall proportion of Iron in compariſon of the afore-mentioned Ores it is ſaid to yield, namely 40 or 45 per cent. as Manganeſe muſt deſtroy much of it, by imparting Oxygen.

To this Family we may alſo refer the liver coloured Hæmatites ſent to Mr. KLAPROTH from CORNWALL, as a Tungſtenic Ore, but which that able Analyſt ſoon found to conſiſt of Iron aſſociated with a conſiderable proportion of Manganeſe. Having mixed it with its own

* Mem. Petropol. 1785. 270.

† Traite des Mines defer. 205.

‡ 2 Chym. Ann. 1784. 82.

weight

[redacted]

weight of Tartarin, and expoſed it to a white heat, he found it did not melt, but aſſumed a dirty dark green colour ; on pouring water on this he found it vary its colours like Alkalized Manganeſe; firſt green, then violet, &c. the ſolution filtered and ſaturated with Vitriolic Acid, became crimſon red, and depoſited the Calx of Manganeſe, the dark brown powder which remained on the filtre being waſhed, dried and heated was Magnetic. 1 Berl. Beob. 187.

Note. A fibrous texture is eſſential to all hæmatitic Ores.

THIRD FAMILY.

Compact Brown Iron Stone.

Dichter Brawn Eiſen Stein of Werner.

Mine de fer hepatique, of the French.

Light or deep nut brown, or yellowiſh brown, or tomback brown or browniſh black. Found maſſive, diſſeminated, inveſting, ſtalactitic, tubular, cellular, nodular, globular, arboreſcent, or cryſtallized in Rhombs, as ſecondary Cryſtals, &c.

External Luſtre caſual. Internal Luſtre 0. 1. Metallic, or nearly ſo. Tranſparency 0.

Fracture, even ſometimes paſſing into the earthy or fine grained uneven, or groſs conchoidal when mixed with brown hæmatites. Fragments 2. rarely preſents columnar or lamellar diſtinct concretions.

Hardneſs from 6 to 8. rarely 9. brittle. Specific Gravity from 3,4771 to 3,5027. Brisson. I found that of the ſpecimen Leske O. 2591 to be 3,551, and of the ſpecimen O. 2593 to be 3,753 ; but

but this ſpecimen gave Fire with Steel, and ſeemed to contain a mixture of Specular Ore.

Streak, reddiſh, or yellowiſh dark brown, or black.

When heated it blackens and becomes Magnetic, to Borax it gives a yellowiſh or Olive green colour.

FOURTH FAMILY.

Brown Scaly Iron Ore.

Braun Eiſen ram of Werner.

Eiſen man of others.

Its colour is intermediate between the tomback or nut-brown, and ſteel-grey.

Generally found INCUMBENT on other foſſils, ſometimes detached, imperfectly rounded or branchy.

Luſtre from 1 to 2. Metallic.

Fracture ſeems fine FOLIATED or SCALY, paſſing into the EVEN.

Fragments 1, 2.

Hardneſs from 3 to 5 brittle, light, ſo as often to float on water. Stains the fingers, or marks ſtrongly, feels ſomewhat unctuous. From its lightneſs ſome have called it EISEN BLUTHE.

Before the blow-pipe it blackens and gives to Borax a greeniſh yellow colour.

It has often been miſtaken for the Red Ore of Manganeſe, from which it differs in colour, but principally in this, that this laſt gives a violet or reddiſh brown colour to Borax.

FIFTH

FIFTH FAMILY.

Brown Iron Ochre.

Ockriger braun Eisen Stein of Werner.

Its colours extend from the nut-brown to the Ochre yellow, and Orange.

Found maſſive and diſſeminated.

Tranſparency o.

Luſtre o.

Fracture EARTHY.

Hardneſs from 3 to 4. Strongly ſtains the fingers.

Yellow Ochre ſlightly heated reddens. Before the blow-pipe it blackens and gives Borax a yellowiſh or olive-green colour.

The yellow contains about 39 per cent. of Oxygen, of which it loſes part by heat and then reddens; the brown only belongs to this Tribe. The earth called Umber Vol. 1ſt. p. 197. is often of this Family, as it frequently contains 33 per cent of Iron.

SIXTH FAMILY,

Black Iron Stone.

Schwartz Eiſen Stein of Werner.

Its colour is intermediate between the Steel-grey, and bluiſh-black.

Found Amorphous, Nodular, Coralliform.

Luſtre 1. 2 Semi-Metallic or Metallic. Tranſparency o.

Fracture

Fracture FLAT CONCHOIDAL, paſſing into the EVEN, or fine grained UNEVEN; ſometimes ſhews curved lamellar diſtinct concretions turned outwards.

Fragments 3.

Hardneſs from 6 to 7. brittle. Heavy. Its ſtreak brighter.

Mr. WERNER has lately diſtinguiſhed it from the Compact Grey Manganeſe with which it was uſually claſſed. It probably contains much of that Semi-Metal. LENTZ adds, that it is exceedingly fuſible, and gives good Iron, but is apt to corrode the walls of the Furnace.

THIRD TRIBE.

MINERALIZED BY FROM 29 TO 36 PER CENT. OF OXYGEN.

Theſe Ores blacken and often become Magnetic by digeſtion in Cauſtic Volalkali. Mem. Par. 1788. 380.

FIRST FAMILY.

RED HÆMATITES.

Rother Glaſskopf, or Faſriger roth Eiſenſtein of Werner.

Browniſh red, or between that and ſteel-grey; ſometimes inclining to the one and ſometimes to the other.

Found maſſive, diſſeminated, nodular, botryoidal, tabular, cellular, tubular, and ſtalactitic.

External Luſtre caſual 2. Internal 1,5 Metallic, or Semi-Metallic. Tranſparency 0.

Fracture

Fracture coarſe or fine FIBROUS ſometimes parallel, but commonly ſtellular or merely diverging and preſenting thick or thin Columnar, and often thick or thin curved Lamellar, ſometimes ſpecular diſtinct Concretions.

Fragments Specular, or Cuneiform, or Amorphous 3.

Hardneſs from 9 to 10, brittle. Specific Gravity 4,898. BRISSON. 4,74 GELLERT. I found that of the ſpecimen LESKE O. 2541. to be 5,005. Streak Blood Red.

Before the blow-pipe it becomes ſomewhat darker; to Borax it gives a yellowiſh olive green tinge.

This Ore often contains beſides a portion of Manganeſe, a large proportion of Argill, which renders the Iron it affords REDSHORT. That of KNOLLEN, near LAUTERBERG, in the HARTZ, was found by Mr. GMELIN to contain 8 per cent. of Argill, and affords about 80 of Iron. 1 Chym. Ann. 1793. 387.

Baron BORN aſſures us it is often mixed with Calcareous EARTH, and then effervesces with Acids. 2 Raab. 287.

The Baron and 2 BERGMAN, 434. alſo mention a YELLOW HÆMATITES, which, he ſays, differs from this only in preſenting a yellow powder when pulverized. 2 Raab. 288.

SECOND FAMILY.

Compact Red Iron Stone.

Dichter roth Eisen stein of Werner.

Its colour is intermediate between the brownish Red and Steel Grey; sometimes participating more of the former, but more generally of the latter; rarely passing into the Blood Red.

Found massive, disseminated, or rounded, nodular, cellular, columnar, stalactitic, rarely specular or chrystalized in middle-sized cubes, implicated in each other or in tetraædral, or acute angled 3 sided, or 6 sided pyramids; the surface of the pyramids rough and dull, they seem to be secondary, the cubes smooth.

Internal Lustre 1. 0. Transparency 0.

Fracture either EVEN or UNEVEN, and then often passing into the slaty, or CONCHOIDAL, scarce ever presents separate columnar concretions.

Fragments from 2 to 3.

Hardness from 7 to 9. brittle. Specific Gravity 3,503 before absorption of water, and after absorption 3,528 per BRISSON; supposing it to be what he calls HÆMATITE TERREUSE. I found that of the Specimen of LESKE O. 2532. to be 3,423.

Streak Blood Red, and stains the fingers.

Before the blow-pipe it blackens, and to Borax gives a yellowish olive green tinge.

On FICHTELBERG in BAYREUTH, it is found in 3, 4, 5, 6 and 7 sided columns, nearly as Basalt.

Of this sort is the LANCASHIRE Ore, sometimes used at CARRON in SCOTLAND. Exter-

nally

nally it is inveſted with a roſy Red Ochre; internally, its colour is purpliſh grey.

Found maſſive, cavernous, and rifty.

Luſtre 1. or 1,5, Semi-Metallic, with ſome diſperſed particles of a more perfect Metallic Luſtre.

Fracture UNEVEN, partly EVEN, or paſſing into the imperfect CONCHOIDAL.

Hardneſs 8. Specific Gravity 3,760. Streak Blood Red. Gives no ſmell when breathed on.

THIRD FAMILY.

RED OCHRE.

Ockriger roth Eiſen ſtein of Werner, or rother Eiſen Ocker.

Its colour Blood Red, more or leſs dark.

It is found ſometimes looſe, ſometimes indurated.

Luſtre 0.

Fracture EARTHY, ſometimes ſlaty.

Hardneſs from 3 to 4. brittle, rarely 5. ſtains the fingers. Heated, it blackens. It does not effervesce with Acids unleſs mixed with mild Calx as it often is in ENGLAND.

REDDLE (ROTHEL) differs but little from ſome Varieties of this. It has been deſcribed in my firſt Volume, among the Calorific earths of the Argillaceous Genus.

FOURTH FAMILY.

Red Scaly Iron Ore.

Rother Eisen-ram of Werner.

Its colour is intermediate between the Mortdore or cherry Red, and dark Steel grey; sometimes inclining more to the one, and sometimes to the other; sometimes discovering shades of Red, sometimes fully Red, or brownish Red.

Found rarely in solitary masses, or disseminated; more generally incumbent, and adhering to other Fossils, particularly Iron Ores.

Lustre 1. 2. silky inclining to the Metallic. Transparency 0.

Fracture curved FOLIATED, or scaly with fine grained distinct concretions.

Fragments 0.

Hardness from 3 to 4. brittle. Heavy.

Feels somewhat unctuous. Stains the fingers. Reddens when heated, but before the blow-pipe it blackens and gives Borax an olive green tinge. It is distinguishable from the brown scaly Ore by its colour, lustre and weight. To KARSTEN we owe the description of both.

WIEGLEB analysed an Ore, which by the description seems to be this but impacted in Coal, and found it to contain 62,5 Carbon, and 37,5 Calx of Iron. 2 Chym Ann. 1789. 299.* Yet BARON BORN assures us that this Ore is a Calx of Manganese, 2 RAAB. 289.

I had not enough of it for examination. The Coal seems foreign to it.

* See also Rinman. §. 57. 10.

[redacted]

FOURTH TRIBE.

Calces of Iron mixed with a notable Proportion of Clay.

ARGILLACEOUS IRON ORES.

FIRST FAMILY.

Upland Argillaceous Iron Ore.

FIRST VARIETY.

Common Argillaceous Iron Stone.

Gemenier thonartiger Eisenstein of Werner.

Its colour is steel or reddish or yellowish grey, or yellowish and dark nut brown, or blackish brown, or dark brick red, or dark Ochre yellow. The grey becomes blacker by exposure to the air.

Found massive, disseminated, cellular, and in petrified foreign forms, rarely octohædral, and then a secondary Crystal. The surface often uneven and bunchy.

Lustre o. Transparency o.

Fracture, compact EVEN, UNEVEN, or gross CONCHOIDAL sometimes splintery, or slaty.

Fragments o, 2.

Hardness

Hardneſs from 3 to 4. Sometimes 6 or 7.

Specific Gravity of the ſpecimen LESKE O. 2651, was 2,936. Of the ſpecimen O. 2647. was 2,692. But the Iriſh and Scotch Ores are heavier.

Before the blow-pipe it blackens, and to Borax gives an Olive green, but blackiſh glaſs.

The ſofter adheres to the tongue; feels dry. It gives a reddiſh yellow ſtreak, and a ſtrong earthy ſmell when breathed on.

On an Ore of this kind the celebrated Iron Founderies of CARRON in SCOTLAND are principally founded. Of which, as Mr. JARS gives no particular account, tho' he ſays that in all his travels he met none like it.* I hope a detailed deſcription will not be unacceptable.

Its colour is partly light, partly dark BLUISH GREY, ſome ſpecimens are alſo of a light, or whitiſh purple externally, but internally DARK OCHRE YELLOW.

It is found in maſſes apparently thick ſlaty, and in Nodules, in an adjacent Coal Mine of which it ſometimes forms the roof.

Luſtre 0. 1. Tranſparency 0.

Croſs fracture Compact, UNEVEN, or imperfectly CONCHOIDAL. longitudinal, EVEN.

Fragments 2.

Hardneſs from 5 to 6. Specific Gravity of the light grey, found by Dr. ROTHERAM, before calcination 3,434 after calcination 3,652 Of the dark grey, before calcination 3,205. after calcination 4,190. Of the yellowiſh, before calcination 3,357.

Streak of the light grey, DARK RED. Of the yellowiſh, YELLOW.

* Voy. Metall. 272.

Gave

Give out no ſmell when breathed on. Theſe afford about 30 per cent. of Caſt Iron

The Ore of ARINGA in the County of ROSCOMMON which if duly attended to might be rendered equally advantageous, much reſembles the dark grey ſpecimens above mentioned.

Its colour is greyiſh black, but externally it is covered with a rind, partly pale yellowiſh, and partly reddiſh brown Found maſſive, frequently in quadrangular forms.

Luſtre 0. Tranſparency 0.

Fracture fine SPLINTRY, or paſſing into the imperfectly CONCHOIDAL.

Fragments 3.

Hardneſs 7. Specific Gravity before calcination 3,471. after calcination 3,626. by my trial. My experiments were however made but on one ſpecimen in each ſtate.

Of this ſort alſo we may reckon the TRAPPOSE ORE uſed even in SWEDEN, of which the whole Mountain of TABERG is ſaid to conſiſt. By CHEVALIER NAPION'S account it is a trap over loaded with Iron, of which it affords about 24 per cent.*

Its colour is greyiſh black.

Luſtre, 0.

Fracture compact, fine grained UNEVEN.

Hardneſs from 7 to 8, gives an EARTHY ſmell when breathed on. 2 BERGMAN Jour. 1789, 2003.

Theſe Argillaceous Ores give the moſt tractable Iron for all purpoſes, tho' not in the greateſt abundance, ſeldom more than 30 per cent.

* Bergman tells us, that common Trap, or Baſalt contain 24 per cent of Iron.

To

To this we may annex, at least as a sub-variety, the whitish Argillaceous Iron Ore described by RINMAN in the Mem. of Stockh. for 1754. p. 297.

Its colour is yellowish white, has the appearance of a Marl, does not diffuse nor become viscid with water, nor dissolve in acids; hardens when heated. Its Specific Gravity 3,451. and affords 40 per cent of Iron, and 14 of Zinc.

The white Argillaceous Ore mentioned by HACQUET*, found near SMOLLNA is probably of this sort.

SECOND VARIETY.

COLUMNAR, OR SCAPIFORM IRON ORE.

Stanglich thonartiger Eisen stein of Werner.

Dark brownish red, or intermediate between that and the blood, flesh, and cherry red, formed of slender, rarely thick columns adhering to each other, but easily separable, commonly incurvated, their surface rough.

Lustre 0. Transparency 0.

Fracture EVEN, or EARTHY, inclining to the minute CONCHOIDAL

Hardness from 4 to 5 brittle. Streak dark red. Slightly stains the fingers Strongly adheres to the tongue. Sounds hollow when struck, feels dry.

Before the blow-pipe it blackens, with Borax it effervesces, giving it an olive-green and blackish

* 2 Chym. Ann 1789. 140.

tinge.

tinge. Both theſe Varieties frequently give 50 per cent. of Iron. I ſuppoſe the weight is conſidered after Calcination.

THIRD VARIETY.

ACINOSE,

Linſenformig korniger thonartiger Eiſen Stein of Karſten, or Korniger Thonartiger Eiſen Stein of Werner.

Its colour is dark browniſh-red, or reddiſh-brown, or paſſing into the yellowiſh-brown, or Steel-grey, or greeniſh-black.

It is found maſſive, or in petrifactions, commonly lenticular.

Luſtre 1,5. 2. Semi-metallic, or metallic.

Fracture, EVEN, UNEVEN or SPLINTERY, or thin SLATY.

Fragments 1.

It conſiſts of ſmall or minute diſtinct granular concretions.

Hardneſs 5. rarely 9. brittle.

Specific Gravity of the ſpecimen O. 2655. is 2,673 by my trial. It gives Fire with Steel, and its Luſtre is 2. It is ſaid to afford from 30 to 36 per cent. of Iron, which I think inconſiſtent with its Specific Gravity, unleſs its weight after calcination, be the ground of the calculation, and this I have not tried.

FOURTH VARIETY.

NODULAR, KIDNEY-FORM.

Ætites, or Eagleſtone. Eiſen niere of Werner.

Externally, yellowiſh brown, internally lighter, it has a kernel, whoſe colour is moſtly Ochre yellow.

Its form is generally that of a rounded knob, or approaching more or leſs to the kidney form, ſeldom quadrangular; the ſurface generally fouled with earth.

Luſtre of the external rind, 2. Metallic. Of the kernel, which is ſometimes looſe, 0.

Fracture of the external rind EVEN, or fine SPLINTERY, of the interior fine EARTHY.

Externally it preſents one or more curved lamellar concentric concretions; the kernel none.

Hardneſs from 4 to 7. brittle. Heavy.

Streak light yellowiſh brown, commonly brighter.

FIFTH VARIETY.

PISIFORM, OR GRANULAR IRON ORE.

Bohnerz of Werner.

Its colour is generally brown, or dark yellowiſh, and blackiſh brown, rarely reddiſh brown, or ochre yellow. Occurs in rounded maſſes or grains, from the ſize of a pea to that of a nut, with a rough ſurface.

External

External luſtre caſual. Internal 1., 1,5. 0. Tranſparency 0.

Fracture, EVEN, EARTHY, or FLAT CONCHOIDAL.

Fragments 2. preſents concentric lamellar diſtinct concretions.

Hardneſs from 5 to 6. brittle.

Streak, yellowiſh brown. Of this ſort is the Oolitic Ore found at CREUSOT, near MOUNT CENIS. It is ſaid to contain 50 per cent. of Calx, 20 Argill, and 30 of Iron. 30 Roz. Journal. 63.

SECOND FAMILY.

LOWLAND IRON ORE.

Calx of Iron mixed with a notable proportion of clay, and alſo with Phoſphorated Iron.

Though the compound of Phoſphorus or its Acid and Iron, called SIDERITE, (which was at firſt miſtaken for a peculiar Semi Metal), be not found in nature ſeparate from other ferruginous Ores, yet as the Ores of the Family we now treat of, poſſeſs certain peculiar properties derived from the preſence of this compound, which is intimately mixed with them, it will be proper at the outſet to give ſome account of it.

OF SIDERITE.

Iron in a reguline ſtate united to Phoſphorus is called SIDERITE.

Its colour is dark ſteel grey.

Luſtre 2. Metallic.

Transparency 0.

Fracture, fine grained UNEVEN with minute distinct granular concretions, rarely STRIATED.

Hardness [illegible] very brittle.

Specific Gravity from 6,7 to 6, 1.

Fusible in a somewhat higher heat than Silver, or Copper.

It is not Magnetic till pulverised, and then only in a slight degree.

Easily unites to Iron, renders it more fusible and cold short.

It is very difficultly and sparingly soluble in Acids.

When immersed in a solution of Gold, it slightly precipitates the Gold in its Metallic form. 3 BERGM. 477.

SIDERITIC CALX.

This consists of Calx of Iron united to Phosphoric Acid.

Its colour is dull white.

Soluble in 1500 times its weight of Water.

Soluble also in concentrated Acids, and precipitable from them by Water; gelatinates with the Vitriolic and Marine Acids; precipitable BLUE by Prussian Alkali. 1 Chym. Ann. 1790. 136.

It unites both to Volatil and Fixed Alkalis, and is precipitable by them WHITE, from its solution in Acids.

Before the blow-pipe it is fusible, and to Borax gives a brown tinge. 3 BERGM. 11[illegible].

SCHEELE decomposed this Calx, by triturating one part of it with two of TARTARIN, and four of Water, boiling the mixture for two minutes. The solution became yellow, and deposited the Calx

Calx of Iron on the Filtre. The filtered ſolution contained an exceſs of Alkali which he neutralized with Nitrous Acid, and thus obtained a further precipitate of Iron. Heating the filtered ſolution to expell the fixed air, and letting fall a few drops of Lime Water, he obſerved a white precipitate. Having thus aſſured himſelf of the preſence of the Phoſphoric Acid, he decompoſed the Phoſphorated Alkali by dropping into its ſolution that of Nitrated Mercury, and as this laſt contains an exceſs of Acid, (which conſequently held ſome Phoſphorated Mercury in ſolution) he ſaturated that exceſs by Tartarin. The Phoſphorated Mercury thus precipitated, he edulcorated, dried, and mixed with three times its weight of Charcoal, and by diſtillation obtained, firſt Mercury, and in an hour after Phoſphorus *.

HASSENFRAZ decompoſes the Sideritic Calx by boiling it in a ſolution of mild Volalkali, filters the ſolution, adds an exceſs of Alkali, evaporates and diſtills the remaining Salt with powdered Charcoal, and thus obtains a Phoſphorus †.

To extract the Sideritic Calx from cold ſhort Iron, by means of the Vitriolic Acid, the ſolution ſhould be made without heat, and after filtration, largely diluted The Calx ſlowly precipitates for one or two days. To obtain it more quickly, the Iron ſhould be rapidly diſſolved in Nitrous Acid, and evaporated to dryneſs. The Calx of Iron will thus become inſoluble in this Acid, and a freſh portion added will take up only the Sideritic Calx.

* 2 Chem. Ann. 1785 [illegible].

† 23 Roz. Jour. 308.

If to this solution, only so much Alkali be added as saturates the Nitrous Acid, the Sideritic Calx will be precipitated, but if an excess of fixed or Volalkali be added the Sideritic Calx will be decomposed in proportion to that excess, and the Calx of Iron will be precipitated. See post N. 266.

I now return to the Lowland Ores.

FIRST VARIETY.

MEADOW LOWLAND ORE.

Wiesenerz of Werner.

This is so called because it is found a few feet under the surface of Lowland Meadows.

Its colour is brown, or between the dark blackish and the yellowish brown, both colours often meet in the same specimen, one inside, the other outside. In the Rifts it is partly bluish black and partly Steel grey. The earths incumbent on it, often bestow their own tinge to it.

Found massive, in lumps of various sizes, and often perforated

Its Lustre is variable, commonly more glassy externally, than internally where it is mostly dull.

Whatever Lustre it has is of the common kind.

Fracture, compact, generally minute CONCHOIDAL, or EARTHY, sometimes EVEN, or fine grained UNEVEN, often all in the same mass. The Conchoidal is oftener met in the dark and glossy, the Earthy in the light coloured and duller parts.

Hardness,

[redacted]

Hardneſs, 4. 3. 5. brittle, moderately heavy. Streak, yellowiſh brown.

It ſometimes yields from 32 to 38 per cent. of Iron.

SECOND VARIETY.

SWAMPY IRON ORE.

Sumpferz of Werner.

Dark yellowiſh brown, or dark nut brown, nearly black.

Found in Amorphous lumps or grains, moſtly perforated or corroded and mixed with Sand.

Luſtre o. where the colour is lighteſt, 1. 1,5. where darkeſt.

Fracture, compact EARTHY, or paſſing into fine grained UNEVEN, or, tho' rarely, into the CONCHOIDAL.

Hardneſs from 3 to 4. brittle. The Specific Gravity of the ſpecimen O 2662. is 2,944.

It often contains 36 per cent. of Iron. RINMAN. §. 65. k. 7. and MULLER. 1, Chym. Ann. 1795. 370. Streak, light yellowiſh brown. Generally found under water.

THIRD VARIETY,

MORASSY IRON ORE.

Moraſterz of Werner.

Light yellowiſh brown, or approaching to Ochre yellow.

Found

Found loofe and EARTHY, or in perforated lumps, or crufts.

Luftre o.

Fracture EARTHY, friable, not remarkably heavy. Stains the fingers.

Hardnefs, 3.

An Ore of this, or the former variety in FINLAND contains alfo Plumbago, Sulphur, and Zinc. *per* AGANDER. 2 Chym. Ann. 1789. 280.

SPECIES III.

MINERALIZED BY CARBON.

PLOMBAGINOUS, OR MICACEOUS IRON ORE.

Eifen Glimmer of Werner.

Its colour is bright Iron grey, fometimes bluifh grey, nearly black.

Found in Amorphous maffes, or inverfting, or diffeminated, or cryftallized, generally in thin fmall, or minute hexahædral lamellæ, and in botryoidal groups.

Luftre 2. 3. Metallic.

Tranfparency o. yet the fingle fcales are fomewhat Tranfparent, and tranfmit a reddifh light.

Fracture, FOLIATED generally curved, fometimes plain, or SLATY, prefents thick or thin, coarfe or fine, broad or narrow, diftinct lamellar concretions, rarely granular; fometimes none.

Hardnefs from 5 to 7. brittle.

Specific Gravity of the fpecimen O. 2517. is 5,070. Of the fpecimen O. 2518, is 4,500. and that of the fpecimen O. 2519. is 4,728.

Streak,

Streak, bluiſh grey, in the ſpecimens I tried; ſome ſay Cherry red. Slightly Magnetic. Feels ſomewhat greaſy, does not ſtain the fingers.

The ſpecimen O. 2517 of LESKE, gave Fire with Steel, even where no Quartz was diſcoverable by the naked eye, ſo did the ſpecimen O. 2519, in ſome parts, I ſuſpect them to contain ſome particles of the ſpecular Iron Ore.

The Specimen 2518, O. which I had rendered as pure as poſſible, expoſed to a white heat for three hours, neither gained nor loſt any weight, but was rather more Magnetic, and as bright as at firſt. This ſeems to contradict the opinion of its origin: Yet may poſſibly ariſe from its containing leſs Carbonic matter than Plumbago does. The experiments in RINMAN § 62. 4. clearly indicate the ſtrongeſt analogy between this Ore and the ſcaly ſubſtance there mentioned, and which in the ſame manner remains unaltered in the ſtrongeſt heat.

Before the blow-pipe it is infuſible, and to Borax it communicates a brown but ſomewhat olive green tinge.

SPECIES IV.

MINERALIZED BY CARBON, OR OTHER INFLAMMABLE SUBSTANCE, AND THE PHOSPHORIC ACID.

BLUE MARTIAL EARTH.

Blau Eiſenerde of Werner.

The compoſition of this Earth is not yet well known, its external characters are as follows:

Its colour in its native ſituation, when not ex-

posed to the open Air is frequently white, sometimes brown, or greenish; but when some time exposed to the Air, it becomes BLUE, and so much the deeper as it is longer exposed, until it attains the deepest shade, rarely smalt blue.

Found sometimes in large masses, sometimes only in lumps, or barely disseminated.

Lustre 0. Moderately compact, somewhat dusty.

Fracture EARTHY. Stains the fingers, feels dry, its weight inconsiderable. Readily diffusible in Water.

Generally found in bogs, sometimes in secondary stratified mountains, and always some feet, frequently many under the surface, as in SAXONY, sometimes in the vicinity of rivers as that found near NEUILLY, by MORAND. Hist. Acad. Par. 1769. p. 8. in Octavo.

Soluble both in Acids and Alkalis, but precipitable from either, by the other.

In water it preserves its colour, but blackens in Oils.

Heated on a red hot coal it inflames, and leaves a red powder which is in some degree Magnetic.*

Before the blow-pipe it instantly becomes reddish brown, and melts into a black bead. To Borax it gives a dark yellow tinge, which is probably what BERGMAN calls FUSCA or brown.

That it contains Phosphoric matter was first discovered by KLAPROTH,† but this constitutes but a small proportion of it, for, from eight ounces of the earth he obtained but 13 Drachms of Sideritic Calx. That the Phosphoric matter is in the state of an Acid and not of Phospho-

* Bergman. Sciagr. §. 206.

† 1 Chym. Ann. 1784. 396.

rous,

rous, appears by its eaſy ſolubility, both in Acids and Alkalis; the Alkalis being ſaturated with any Mineral Acid, or the Acids by an Alkali would very naturally depoſit the Sideritic Calx. The inflammability of this Subſtance muſt then proceed from ſome other principle, moſt probably Carbon, perhaps with an aſtringent ſubſtance.

SPECIES V.

BLUE IRON ORE OF VORAU.

Of this ſubſtance I have ſeen no detailed deſcription. KLAPROTH has ſhewn that it differs ſpecifically from that juſt deſcribed, that it contains no Copper, and that it is not a natural Pruſſian Blue; both which opinions were before held.

Its colour is dark ſmalt blue, it does not require expoſure to the Air to acquire this colour, for its freſh fracture preſents it.

It is found in veins running through Gneiſs, and imbedded in Quartz, and tends to a tabular [illegible].

External Luſtre 2. Internal 1. Tranſparency 0. Fracture UNEVEN [illegible] 9 Streak Blue.

Heated it falls to pieces and becomes grey, but gives no indication of fuſibility. With Borax it gives a ſlight yellow, and with Microcoſmic Salt a colourleſs bead.

It is difficultly ſoluble in Acids, and not diſcoloured by Cauſtic Alkalis,* in the moiſt way, but ignited with twice its weight of [illegible] it loſes its colour, and becomes yellow [illegible].

KLAPROTH found it to conſiſt of Silex, Argill and Calx of Iron. 1 KLAPR. 199.

* 4 Berl. Beob.

SPECIES VI.

GREEN MARTIAL EARTH.

Green Eifenerde of Werner.

Light or dark Canary green, and thence paff-ing into the olive green, or yellow.

Commonly found inveſting, or incumbent. Friable, ſeldom indurated.

Luſtre 0.

Fracture nearly EARTHY.

Hardneſs from 3 to 6.

Strongly marks, or ſtains the fingers. Not remarkably heavy. Streak, grey.

Difficultly ſoluble in Acids.

When ſtrongly heated it loſes weight, and blackens. If often or long heated it becomes ſomewhat Magnetic. With Borax it eaſily melts into a yellowiſh brown opake Glaſs with ſome black ſpots.*

According to RINMAN it affords 12 per cent. of Iron.† but it probably contains much more, for by his method, even TRAP afforded but 10 per cent. of Iron.‡

It is ſaid to conſiſt of Argill, Silex, Iron and Manganeſe.

It has been miſtaken for Biſmuth Ochre, an error which WERNER has rectified.

* 2 Bergm. Jour. 1789. 1043.

† Swed. Abhandl. 1754 298.

‡ Ibid. 297.

SPECIES

SPECIES VII.

MINERALIZED BY SULPHUR.

MARTIAL PYRITES.

Of this Species I have treated, under the head of INFLAMMABLES.

SPECIES VIII.

MINERALIZED BY ARSENIC.

ARSENICAL PYRITES.

Of this I ſhall treat among the Arſenical Ores,

SPECIES IX.

MINERALIZED BY THE ARSENICAL ACID.

ARSENICATED IRON ORE.

This ſubſtance was diſcovered in SPAIN by Mr. PROUST, but the account he gave of it is very imperfect. 1 Ann. Chym. 195.

Its colour is greeniſh white.

Its Tranſparency 0.

Its Fracture granular.

Inſoluble in water, and alſo in the Nitrous Acid, even boiling.

Does not ſublime when melted in a crucible, but if heated on Charcoal, the Arſenical Acid eſcapes with effervefcence.

SPECIES

SPECIES X.

MINERALIZED BY FIXED AIR.

CALCAREOUS, OR SPARRY IRON ORE.

Spathiger Eisen Stein of Werner.

When first raised, its colour is generally white, but after a short exposure to the air it becomes yellow, or reddish or greenish grey, or pale or dark Isabella yellow, or dark Gold yellow, or nut brown, or blackish brown, or Iridescently variegated purple or bluish.

Found in Amorphous masses, or disseminated, cellular, rounded, or crystallized in quadrangular or hexangular, or double triangular pyramids, or in four sided pyramids with convex planes, or Rhomboidal with plane or curved faces, or lenticular. The Crystals middle sided, rarely large, or minute. Their surface smooth or drusy.

Lustre 2. 3 1. 0, common or glassy, but the External often Metallic.

Transparency 1. or in thin pieces 2. the darker 0.

Fracture, plain or curved FOLIATED, or granularly FOLIATED in a triple direction, the distinct concretions fine or coarse, plane or curved lamellar.

Fragments tending to Rhomboidal.

Hardness from 5 to 7 brittle.

Specific Gravity 3,672. BRISSON 3,784. GELLERT. and per 2 BERGMAN it extends to 3,810. But if, in some measure decomposed, from 3,3. to 3,6.

Not

Not Magnetic, or at least very rarely. 2 BERGM p. 187. and 227. FOURC[illegible] shewn that a very slight proportion of fixed air prevents Iron from answering the Magnet. Hence if it be digested with caustic Vegetable Alkali, it blackens and becomes Magnetic. [illegible] Chy. Dijon. 176.

Streak, grey or [illegible]te.

Soluble in Acids with a slight or almost imperceptible effervescence. With the Vitriolic Acid it affords crystals of green Vitriol. The Nitrous Acid assumes a yellow colour when saturated with it.

Heated it loses from 15 to 40 per cent of its weight, generally about [illegible] of its weight, the chrystallized specimens decrepitate. The residuum is black and Magnetic. The Amorphous sort does not decrepitate.

Before the blow pipe it becomes brownish black, to Borax it gives a smutty yellow with some effervescence.

It essentially contains Iron, Manganese, and mild Calx*

The Calx generally amounts to from [illegible] to ½ the whole, sometimes only to 2 per cent. In the Ore of EISENERT, Mr. BERGMAN found about 38 per cent. of Iron, 24 of Manganese, and 38 of mild Calx. In one of SWEDEN he found 22 of Iron, 28 of Manganese, and 50 of mild Calx. The Iron was in the same state as in green Vitriol, the Manganese after, and probably before extraction, in that of white Calx 2 Bergm 228.

But all these proportions are variable, more particularly in Ores that have undergone differ-

* It was the Manganese that BAYEN mistook for Zinc, 7 Roz Journ. and 9 Scav. Etrange.

cnt

ent degrees of decompoſition. This Ore is readily decompoſed by expoſure to the Air, chiefly by reaſon of the Manganeſe contained in it. When ſo far decompoſed as to become black, both this and the calcareous part diminiſh, and the ferruginous part is more difficult to treat, as Mr. La Peyrouse has obſerved.

Upon the whole however this is looked upon as perhaps the very beſt of all the Iron Ores, as it affords the beſt Iron for the nicer purpoſes, the beſt Steel, in greateſt plenty, and with the greateſt eaſe and leaſt expence. Hence it is generally called Steel Ore.

It is frequently mixed with Quartz, Pyrites, and other impurities.

There is a Variety of this Ore, which Rinman tells us is found in Kent, in Marl pits, and which is alſo uſed, or at leaſt according to Ruckert may well be uſed, as a Manure; its colour is externally grey, or bluiſh grey, but internally brown. Its hardneſs 7. Its weight conſiderable, but Acids make (without particular management) no ſenſible impreſſion on it, by reaſon of the quantity of Argill intermixed with it; yet it loſes 31 per cent by Calcination, and affords 47 per cent. of Iron.*

* Rinman. §. 210.

SPECIES

SPECIES XI.

EMERY.

Smirgel of Werner.

Greyiſh black, verging on blue, or bluiſh grey, or greyiſh brown, or bluiſh black; often covered with a reddiſh, or ſmutty yellowiſh rind; internally it diſcovers reddiſh and purpliſh ſpots. Commonly imbedded in other foſſils, or diſſeminated, rarely ſolitary and then in ſmall pieces in EUROPE, but in the EAST-INDIES it occurs in large maſſes.

Luſtre 1, 0. Common, but in ſome parts 2. Metallic. Tranſparency, 0.

Fracture, coarſe grained UNEVEN, with minute granular diſtinct concretions.

Hardneſs, 14. eaſily frangible. Specific Gravity, 3,92 BRISSON. That of the Specimen 2675. O. of LESKE is 3,356. That of the Specimen O. 2674, is 3,433, Probably BRISSON took his from the beſt Specimen that came from the LEVANT. That of another which Mr. HENDERSON, (who had collected it among other curious Minerals at PETERSBURGH,) had the goodneſs to preſent me, was 3,330. It ſlowly imbibed water, and was probably ſtill denſer.

According to Mr. WIEGLEB's analyſis it contains 95,6 per cent. of Silex, and 4,3 of Iron.

If ſo, it can ſcarce be reckoned among Iron Ores. It is uſed only for poliſhing, but I have not the leaſt doubt but ſome other ſtone was impoſed upon him for it.

* Rinman. §. 210.

Before the blow-pipe it blackens, and to Borax imparts a ſmutty yellow tinge.

SPECIES XII.

TUNGSTENIC IRON ORE.

Its colour is pale red, or pale yellow, or fleſh coloured.

Found maſſive in the mine of BASTENOS, in SWEDEN, ſeldom cryſtalized.

Fracture coarſe grained UNEVEN?

Hardneſs 9. Brittle. Specific Gravity, 4,988.

Streak, white. Its powder is alſo grey or white.

It does not effervefce with acids.

By heat it loſes ſomewhat of its weight, and becomes light brown, but is ſcarcely fuſible in the ſtrongeſt blaſt heat. By the addition of Coal it becomes magnetic and darker, but is rendered fuſible by its own weight of Fluor. By a flux of one part powdered Charcoal, one of Sal Ammoniac, one of Egg-ſhells, half of Borax, ¼ of Soot, and one of Glaſs CRONSTED obtained from it in one hour and a quarter, 30 per cent. of Iron, brittle, but Magnetic. SWEDISH ABHAND. 1751. p. 235.

CHAP.

CHAP. VI.

TIN.

The colour of Tin is greyiſh white.

Luſtre 3. Tranſparency 0.

Fracture hackly, crackles between the teeth, or when bent. Hardneſs 6.

It is the lighteſt of all Metals.

Specific Gravity of the pureſt Cornish Tin melted but not hammered 7,291. Hammered 7,299. Of MALACCA Tin melted, 7,296. Of the ſame hammered, 7,306.—BRISSON. But DR. WATSON found that of Engliſh Tin ſimply melted, 7,170. 4 WATSON, 165. According to GELLERT, that of Tin of GALLICIA in SPAIN, is 7,063, and that of the Tin of EHRENFRIEDENSDORF in SAXONY, is 7,271. Hence we may conclude, that any Tin whoſe Specific Gravity is higher than 7,306 when hammered, or 7,299, if ſimply melted, or below 7,06, is impure.

It is fuſible at a lower degree of heat than any other metal, its calces tinge fluxes white.

It is ſoluble in *Aqua Regia* without heat, in Marine Acid in a ſlight, and in Vitriolic in a ſtrong heat. Nitrous Acid, unleſs dilute and with particular management, only calcines it.

It is precipitated when freſh made, *Purple* by and with the ſolution of Gold.

SPECIES II.

Mineralized by Oxygen.

FIRST FAMILY.

Common Tin Stone.

Zinstein of Werner.

Brown, dark or blackish brown, or yellowish, or reddish brown, or brownish black, or yellowish grey, approaching to the Isabella, or ash grey, or nearly white, or yellowish and blood-red, or brownish red.

Found massive, or coarsely or minutely disseminated, or in blunt, or spicular Fragments, or crystalized, frequently in middle sized or small quadrangular masses, but as these crystals are commonly imperfect or mutilated, their form is not easily determined, I must therefore leave these researches to those who make them their peculiar object. These Crystals have commonly, where not mutilated, some Lustre as 2, or 3, unmetallic, but their internal Lustre is only 2, and of the common kind. The Lustre of the massive is 0.

Transparency of the crystals 0. 1. 2. 3. the darker their colour, the less Transparency they possess.

Fracture COMPACT, generally fine grained UNEVEN, or inclining to the minute CONCHOIDAL, more rarely passing to the imperfectly FOLIATED, often present fine granular, seldom thin and curved lamellar distinct concretions.

Hardness 10.

Specific

Specific Gravity from 6,900 to 6,93. BRISSON. Or from 6,88 to 6,97. GELLERT.* BRANDT found some black Cryſtals in ſhape reſembling Garnets, whoſe Specific Gravity was from 3,312 to 3,60. which afforded him about 4 or 5 per cent. of Tin, or rather the Regulus extracted from them. Swenſk. Hadlung. 1746, p. 183. Streak light grey.

The *Germans* frequently call the larger Cryſtals *Zingraupen*; the ſmaller indiſtinct groups of cryſtals *Zinzwitter*. The maſſive *Zinſtein*. White *Zingraupen* are now known to be an Ore of Tungſtenite, as I have already noticed. The yellowiſh grey is often called *Tinſpar*.

Before the blow-pipe it decrepitates, and on Coal is at leaſt partially reduced. Gives a white tinge to Borax. Borax ſhould always be added to prevent the Metal from calcining too ſoon. Engeſtr. 301. This Ore is generally accompanied by Hornblende, Mica, Quartz, Killas, Chlorite, Molybdena or Wolfram.

SECOND FAMILY,

FIBROUS TIN STONE, WOOD TIN ORE,

Corniſh Tin Ore of Werner, Tin Hæmatites of ſome.

Its colour is light or dark hair brown; when light it often inclines to the yellowiſh grey, or Iſabella yellow. It leſs frequently occurs with two or more parallel but incurvated ſhades of

* Brunich found the Specific Gravity of a Cryſtal he examined, to be only 6,75. but this was in water of the temperature of 6 of Reaumur, that is 46° or 47°. of Fahrenh. Swed. Abhand. 1778. 308.

both

both colours, traverſing obliquely the ſame Specimen.

Hitherto it has been found only in Fragments either rounded or of an indeterminate figure, the ſurface ſomewhat rough. External Luſtre 2. Internal 1. Common.

Tranſparency 0.

Fracture delicately ſtreight FIBROUS, but commonly diverging on one ſide.

Fragments partly indeterminate, partly ſplintery and cuneiform, preſenting long coarſe ſharp diſtinct concretions, with ſpecular ſurfaces and partly curved lamellar.

Hardneſs 9.

Specific Gravity nearly 7,000, as it ſeems by WERNER, BRUNICH found it 5,80, and BLUMENBACH 6,450. Gives a yellowiſh grey Streak.

Before the blow-pipe it becomes browniſh red, and decrepitates when red hot, but is not reduced. Brown Hæmatites is the only foſſil which it reſembles, but it is diſtinguiſhable from it not only by its Colour, Shape, Leſſer Internal Luſtre and Streak, but more eſpecially by its Specific Gravity, which far exceeds that of Hæmatites.*

It contains per KLAPROTH about 63 per cent. of Tin. BRUNICH found ſome ſorts to yield but 34 per cent. by his eſſay; but probably the mode of eſſaying he employed was not ſo juſt.

It has hitherto been diſcovered only in CORNWALL.

* 1 Berl. Beob. p. 152.

SPECIES

SPECIES III.

MINERALIZED BY SULPHUR, AND ASSOCIATED WITH COPPER.

TIN PYRITES.

Zinkies of Werner.

Yellowiſh Grey, paſſing into the Steel grey, and reſembling the grey Copper Ore.

Found Maſſive, and then often mixed with Copper Pyrites, or diſſeminated.

Luſtre 2. Metallic. Sometimes there are dark ſpots whoſe Luſtre is 0. Tranſparency 0.

Fracture partly fine partly coarſe grained UNEVEN, yet in ſome parts approaching to the MINUTE CONCHOIDAL or imperfectly FOLIATED.

Fragments 3.

Hardneſs from 5 to 6, very brittle. Specific Gravity 4,350.

Before the blow-pipe it melts eaſily into a black bead with a ſulphureous ſmell, which alſo depoſits bluiſh Calces on the Coal.

It contains per KLAPROTH's Analyſis, at a mean, 25 per cent. of Sulphur, 35 of Copper, 34 of Tin, 3 of Iron and 2 of ſtony Matter. The darker ſorts, which have leaſt Luſtre contain moſt Iron, (about 8 per cent.) ſome ſigns of Arſenic alſo appeared, but in inconſiderable quantity.

He alſo obſerved that Tin in this Ore is nearly in a Metallic ſtate, for by diſtilling it with corroſive ſublimate he obtained both Cinnabar and Concrete Muriated Tin.

The Sulphurated Tin Ore, ſent to Mr. BERGMAN from SIBERIA, has ſince been diſcovered to be an artificial product. 1 Chym. Ann. 1790. 53.

Pure

Pure Sulphurated Tin produced by art is of a Lead grey colour, and scaly texture, like MOLYBDENA, per PELLETIER. 13 Ann. Chym. 237.

In CORNWALL the best Tin Ores are those that are washed down the hills by torrents, and thence called STREAM TIN ORES, they are all of the first and second Species, and contain neither Sulphur nor Copper. The Tin extracted from them is called GRAIN TIN, and not easily procured in general; common BLOCK TIN being extracted from Sulphureous Ores is not quite so pure. Grain Tin approaches to the silvery white. Common block Tin is bluer.

The German Ores, contain much Iron and Sulphur, but the MALACCA or BANCA Tin, from the EAST INDIES is reckoned as pure as the CORNISH.

What in GERMANY is called English Tin contains 3 per cent. of Lead, as LENTZ informs us.

It is remarkable that Tin has not as yet been found in any Stones of the Calcareous or Barytic Genus, except Fluors, and Phosphorites, but chiefly in those of the Siliceous and Argillaceous kind, As Quartz, Granites, Argillites, Hornblende, &c. and associated with Tungsten, or Molybdena.

GELLERT observes that Tin Ores do not decrepitate when heated, whereas most others do.

CHAP. VII.

LEAD.

The colour of Lead is bluiſh white, when tarniſhed it becomes firſt yellowiſh white, then bluiſh, and at laſt bluiſh black.

Luſtre, when untarniſhed, 3.

Hardneſs 5.

Specific Gravity 11,352, BRISSON. He did not find the denſity to increaſe, or at leaſt but very inconſiderably by malleation, nay it ſometimes decreaſed. According to GELLERT the Specific Gravity of that of FREYBURG is 11,445. probably it was freer from Iron than that tried by BRISSON. The heavieſt is the beſt.

It ſtains paper or the fingers, bluiſh black when rubbed thereon.

Next to Tin it is the moſt fuſible of all metals. In a cuppelling heat it evaporates and loſes from 6 to 8 per cent. of its weight.

Soluble colourleſs in moſt Acids, but moſt eaſily in the dilute Nitrous, yet precipitable from this by the Marine Acid, and from the Marine by the Vitriolic.

By expoſure to air and moiſture it ruſts or calcines, tho' much more ſlowly than Iron.

SPECIES. I.

NATIVE LEAD.

The exiſtence of Lead in this ſtate is at preſent very generally denied, and from the eaſy calcination of this metal, by air and moiſture, it muſt be

be allowed to be ſomewhat doubtful, yet to deny it abſolutely, is in this, as in many other caſes, rather raſh, particularly as the ſpecimen found in MONMOUTHSHIRE has all the appearance of being in a perfect metallic ſtate, and no ſolid proof deſerving attention, nor even a well grounded ſuſpicion of its having been produced by art, has as yet been adduced.

SPECIES II.

MINERALIZED BY OXYGEN AND FIXED AIR.

Of this there are three Families, the White, the Yellowiſh Grey, and the Red.

FIRST FAMILY.

WHITE LEAD ORE.

Weis Blyerze of Werner.

WHITE LEAD SPAR, OF SOME.

Its colour is ſilvery or pale white, or greyiſh, or greeniſh white, or dark grey inclining to the nut brown, or reddiſh grey, rarely apple green, ſometimes Iron ſhot and then yellowiſh. The ſilvery white often reſembles Mica, being found in Spangles.

Occurs either maſſive, or coarſely or minutely diſſeminated, or inveſting, or lamellar, or cellular, ſpecular, or cryſtalized in middle ſized 6, 4. or many ſided priſms, or pyramids, with or without truncations, or more commonly, acicular, fibrous, interwoven, accumulated, &c.

External Luſtre 3. 2. 1. Waxy or ſilky rarely ſemi-metallic. Internal 1. 2. Common or ſaline rarely ſemi-metallic.

Tranſparency 2. 3. 1. 0. 4.

     Fracture,

Fracture, of the maſſive perfectly or minutely CONCHOIDAL, or intermediate between the CONCHOIDAL AND THE UNEVEN. Of the cryſtalized FIBROUS, the croſs fracture UNEVEN.

Hardneſs from 5 to 6, brittle.

Specific Gravity of the more Tranſparent 6,558., BRISSON, or from 6,250 to 6,920, GELLERT. Of the opake 4,058, BRISSON, or 5,84, GELLERT. Of one from the Silver Mines in the County of TIPPERARY, 5,667. whoſe Tranſparency was 1. of another from the ſame place entirely opake 5,349. Effervesces with the Nitrous or Marine Acids when heated; ſlightly while cold; but ſcarce at all with the Vitriolic. It is alſo ſoluble in fat Oils which other ſubſtances that reſemble it, are not.

Heated it decrepitates, then turns yellow and afterwards red, and if placed on Charcoal is immediately reduced, and ſo it is in a crucible if it be pulverized and mixed with any Oily or Gummy ſubſtance.

It blackens with Sulphurated Volalkali, which immediately diſtinguiſhes it from aerated or vitriolated Barytes as PELLETIER has well remarked.

It is ſeldom free from mild Calx of Iron, hence its proportion of Lead varies from 60 to 85 per cent.

The Aerial part is from 18 to 24 per cent

What is called Native Glaſs of Lead, is nothing elſe than this Ore, in its maſſive form. Its internal Luſtre 3. Tranſparency 2. 3. Fracture CONCHOIDAL or SPLINTERY. and ſcarcely efferveſes with Acids.

SECOND

SECOND FAMILY.

EARTHY, YELLOWISH, GREENISH, OR BLUISH GREY LEAD ORE, OR OCHRE.

Zerreibliche and Verhartete Bleyerde of Werner.

Of this family there are two distinctions, for either it is found in a loose EARTHY state, easily PULVERIZABLE and DUSTY, generally seated on GALENA, or in the cavities of other fossils, rarely solitary, perfectly dull and sullying the fingers, but weighty, and effervescing with Acids, at least when heated, easily reducible by the blow-pipe unless too earthy, or INDURATED—And in this not only the yellowish grey, but also the bluish and greenish grey colours, and also the Sulphur and Ochre yellow occur tho' more rarely, often speckled with brown.

It is found massive. Lustre 0. yet in some specks 2. 1. Transparency 0. 1.

Fracture COMPACT, fine grained UNEVEN, or tending to the CONCHOIDAL, or EARTHY.

Hardness from 6 to 7. Sometimes 8. Specific Gravity 5,461 per GELLERT. Of the specimen O. 2842, I found it 4,165. Its streak has some lustre.

Effervesces (tho' weakly) with Nitrous or Marine Acids, when heated. Blackens with sulphurated Volalkali. It is easily reducible by the blow-pipe.

The constitution of these Ores, differs from that of the former only in cohesion, or containing a greater proportion of Earth, Argillite, Iron, or other hetrogeneities and less fixed Air, sometimes scarce any. The yellow frequently refuse to effervesce

effervefce with Acids, and may be fufpected to contain the Molybdenous Acid, tho' this laft Ore has always fome luftre.

Some of thefe yellow Ores Mr. MONNET tells us he found compofed of Calces of Iron of Antimony, and of Lead. The two former calces making $\frac{2}{3}$ of the whole. Mem. TURIN. 1788. 369.

THIRD FAMILY.

EARTHY RED LEAD ORE.

Rothe Bleyerde, of Werner.

Brownifh RED, inclining to grey.

Found maffive.

External Luftre 0. Internal 1. Tranfparency 0.

Fracture, COMPACT, UNEVEN fmall grained, fometimes EVEN fmall grained, or imperfectly CONCHOIDAL.

Fragments 2.

Hardnefs 6. Specific Gravity of the fpecimen 2848, O. 5 545. And of the fpecimen 2846, O. only 4,778.

Gives a white or reddifh white ftreak deftitute of luftre.

Effervefces with Acids. Slightly with the Nitrous more readily and permanently with the Marine with which it affumes a yellowifh green colour; with Vitriolic Acid both folutions give a copious precipitate.

It is difcoloured by Sulphurated Volalkali.

Mr. De LA METHERIE informs us that this Ore is often nothing more than a red marl impregnated with the white Calx of Lead. 2 MANUEL. p. 119.

Before

Before the blow-pipe it is eaſily reduced, leaving a black ſlag. But ENGESTROM remarks that if the earths be in conſiderable proportion no Lead can thus be obtained.

SPECIES III.

PHOSPHORATED LEAD ORE.

Grünes Bleierz, of Werner.

Its colour is moſt commonly GREEN, including every poſſible ſhade thereof, but the Olive Green ſeems to occur ofteneſt.—Or yellowiſh, or greyiſh red, or browniſh red, or browniſh yellow, or greyiſh white.

Found maſſive, diſſeminated, Botryoidal, Tuberoſe, ſtalactitic, or cryſtallized, in ſmall or minute 6 ſided priſms generally thicker in the middle than at the ends, often with the planes hollowed, or in pyramids acicular or maſſy or in cuneiform lamellæ or criſtated.*

EXTERNAL Luſtre, 2. 3. Waxy. (that of the whitiſh grey acicular Cryſtals. 0.) INTERNAL, 2. 1. Common.

Tranſparency of the maſſive, 1. Of the cryſtallized, 2. 3. 1. Of the greyiſh white 0.

Fracture fine grained UNEVEN, or intermediate between that and the SPLINTERY, often inclining to the CONCHOIDAL.

Hardneſs from 5 to 6. brittle

* Maquart, 556.

Specific

Specific Gravity from 5,86 to 6,076, BRISSON* 6,593, GELLERT 6,270, KLAPROTH.†

Streak of the greenifh, is greenifh white, the powder yellowifh.

It is not altered by expofure to the atmofphere, nor foluble in water hot or cold.

Difficultly foluble in Nitrous Acid hot or cold, ftrong or dilute, Nay FOURCROY fays it is infoluble in the pure colourlefs Nitrous Acid. Nor does the Vitriolic Acid attack it, unlefs concentrated and boiling, and then reduces it to powder. But the Marine Acid diluted and heated diffolves it with a flight effervefcence, and forms with it acicular Cryftals.

Heated on Charcoal with a blow-pipe it quickly melts, and if flowly cooled forms Opake polyhædral Cryftals but is not reduced. If it be heated in a retort with $\frac{1}{12}$ of its weight of Charcoal, luminous vapours appear, a phofphorus paffes and the Lead is reduced. So alfo if it be heated with Soda on Charcoal, the Lead is in fome meafure reduced. 5 BERL. BEOB. 178.

This Ore contains about 72 per cent. of Lead, per LAUMONT. 28 ROZ. JOUR. per FOURCROY that of EHRLENBACK in ALSACE contains 79 per cent. of Calx of Lead, 18 Phofphoric Acid, 1 of Iron, and 2 of Water. 2 Ann. Chym 218, per KLAPROTH that of ZCHOPAU contains 72,08 per cent. of Metallic Lead, 18,74 of Phofphoric Acid,‡ and 1,5 of Iron, the remainder is chiefly Air, as the Lead is in a Calcined State.

* See his Treatife on Specific Gravities, and 2 Chym. Ann. 208.

† 1 Crell Beytr. 14.

‡ 1 Crell Beytr. 2 Stuck, 20.

per

The greenifh fort is moft common in AUSTRIA and CARINTHIA, &c. The brownifh red cryftalized fort has hitherto been noticed chiefly at HUELGOAT in BRITTANY. It is faid to have lately been found in the Mine of HOFF near SCHEMNITZ, in the form of white Lead Spar. 39 Roz 363. KLAPROTH attributes the greenifh colour very properly to the Iron contained in it.

Per BINDHEIM, the green Lead Spar of SIBERIA, contains 64 per cent. of Lead, 6 of Copper, 2 Calx of Iron, 10 Phofphoric Acid, 3,5 Silex, and 10,5 of Water and Air. 5 BERL. BEOB. 10.

SPECIES IV.

MINERALIZED BY THE ARSENICAL ACID.

ARSENICATED LEAD ORE.

Of this which has hitherto been detected only in SPAIN, we have but an imperfect account from Mr. PROUST.*

Its colour he tells us is MEADOW GREEN, often paffing into the Wax yellow, found in fmall maffes, granular or botryoidal.

Luftre 2. Waxy. Tranfparency 2.

Treated with the blow-pipe it reddens before it melts, and retains its colour It melts more difficultly than Phofphorated Lead does. To decompofe it, it muft be heated to whitenefs, then the Arfenical Acid efcapes with effervefcence and the Lead is reduced.

* 30 Roz. Jour. 394.

SPECIES V.

Mineralized by the Arsenical and Phosphoric Acids jointly.

Arsenico-Phosphorated Lead.

Its colour is yellowish GREEN, or it presents alternating layers of pale and deep GREEN.

It is found massive superficially investing Fragments of Quartz, in thickness from $\frac{1}{8}$ to one Inch, flat, tuberose or botryoidal, or Crystallized in small truncated hexahædral prisms, with incurvated planes.

Lustre. . . Transparency of the massive 0. Of the Crystallized 2.

Fracture, FIBROUS, STRIATED, or CONCHOIDAL.*

Hardness from 5 to 7, brittle.

Specif. Gravity 3465. BRISSON.

Its powder is not so green, but rather yellowish.

Hence we see it differs from the Phosphorated Lead Ore, in Fracture and Specific Gravity, and perhaps it would be found to do so in other respects, if the description were more exact †

* I suppose the Massive, Striated or Radiated, and the Crystallized to exhibit the Conchoidal Fracture, as these two seldom meet.

† It is taken from 2 Ann. Chym. 25 and 26. and formed when Mr. Werner's method of describing was not generally known.

Its relation to Acids is much the ſame as that of the Phoſphorated Ore, the dilute Marine Acid is its beſt ſolvent. According to FOURCROY neither the pure nor Mephito-Nitrous Acid, hot or cold, has any action on it.

If briſkly heated, it decrepitates. Treated with the blow-pipe on Charcoal it melts quickly, effervesces and emits a white ſmoke with an Arſenical ſmell, a few particles of Lead are reduced, a browniſh fluid remains which on cooling cryſtalizes like Phoſphorated Lead.

According to Mr. FOURCROY 100 parts of this Ore contain 65 of Arſeniated Lead, 27 of Phoſphorated Lead, 5 of Phoſphorated Iron, and 3 of Water. 2 Ann. Chym. 3½.

SPECIES VI.

MINERALIZED BY THE VITRIOLIC ACID.

NATIVE VITRIOL OF LEAD.

Its colour is white.

Found Cryſtalized, the cryſtals very minute being only from 1/8 to ¼ of an Inch in length. They appeared to me oblique angled quadrangular.

Luſtre 4. Tranſparency 4.

420 Grains of boiling Water diſſolved one third of a grain of theſe Cryſtals, and in the ſolution Muriated Barytes formed a precipitate.

Treated on Charcoal with a blow-pipe the Lead was ſoon reduced.

I found theſe Cryſtals thickly diſſeminated in a reddiſh brown maſs, of Ore ſent to me from

Anglesea, accompanied with a number of brownish red Crystals, irreducible by the blow-pipe tho' easily fusible. These I did not thoroughly examine, but suspect them to be Phosphorated Lead and Iron.

Vitriol of Lead natural or artificial is easily reduced on Charcoal by the blow-pipe, which is one method of distinguishing it from Selenite or Baroselenite.

MURIATED LEAD.

Ferber informs us that an Ore of this nature had been found at Mies and Bleystadt in Bohemia, but he gives no description nor proof of it.* On the other hand Baron Born assures us that the grey Hexahædral Crystals found at Mies, which were there taken for Muriated Lead, were proved by Klaproth to consist of Lead united to the Phosphoric Acid.†

SPECIES VII.

Mineralized by the Molybdenous Acid,

Yellow Molybdenated Lead Ore,

Yellow Lead Spar, of some.

Gelbe Bleyerz of Werner.

Its colour is Citron Yellow pale or dark, or Wax yellow, or passing into the Orange yellow.

* Nov. Act. Petrepol. 1785. 269.

† 2 Raab. 373.

Found

Found maſſive, diſſeminated, or lamellar, or cryſtalized in ſmall Cubic or Rhomboidal or Octohædral tables, or thin plates, often Cellularly accumulated, or Acicular.

Luſtre 2. 1,5. 3. Waxy. Tranſparency 2. 3. 1.

Fracture, minute CONCHOIDAL.

Fragments 3.

Hardneſs from 5 to 6.

Specific Gravity of the maſſive much debaſed with mild Calx 3.?00. JACQUIN 2 MISCELL. AUSTR. 390. Streak white. Sulphurated Volalkali blackens it.

Before the blow-pipe it decrepitates and melts into a yellowiſh and blackiſh grey maſs, which to Borax imparts a bluiſh white colour, and if Nitre be added, it is reduced.

It does not effervefce with Acids, tho' it often SEEMS to do ſo from a mixture of mild Calx inviſibly contained in it, but if it be digeſted with a large proportion of Nitrous Acid, the greater part will be diſſolved in it, and white flakes will appear diffuſed thro' the ſolution. The Muriated Acid alſo diſſolves it by digeſtion, and ſtill better, if the Acid be concentrated, the ſolution will be green, or deep blue if ſtir'd.* But if dilute, colourleſs.†

Mr. KLAPROTH has clearly ſhewn that of CARINTHIA to conſiſt of Lead united to the Molybdenous Acid, but in what proportion he has not determined. 4 BERL BEOB. 103

According to WULFEN, it affords, when treated with filings of Iron and Borax, 54 per cent. of

* 2 Jacquin Miſcell. Auſtr. 399.

† Per Klaproth. 4. Berl. Beob. 102.

Lead,* ſometimes it is ſo impacted with Calcareous particles that it forms a yellow maſs reſembling Litharge. per WULFEN. 2 JACQUIN's Miſcell. Auſtria. 190. who treats of this Ore and the Aerated Ores very minutely.

SPECIES VIII.

MINERALIZED BY AN EXCESS OF OXYGEN, WITH MOLYBDENOUS CALX,

RED LEAD SPAR.

Roth Bleyerze of Werner.

Its colour is Aurora, that is Red with a ſhade of yellow, ſometimes indiſtinct by reaſon of a thin rind of yellow Ochre, or Hyacinth Red.

In France it is ſaid to have been found maſſive, but more generally diſſeminated or overlaying. In SIBERIA it has hitherto occured only cryſtalized in ſmall acute angled four ſided priſms, ſometimes ſmooth, ſometimes longitudinally Streaked, often hollow, rarely in low Hexahædral priſms, with two ſmall and four broad ſides. Theſe Cryſtals are often implicated in each other.

External Luſtre 2. 3. Internal 2. 1,5. Common Tranſparency 2. 3.

Fracture, if made croſſways, FOLIATED. Otherwiſe COMPACT, being fine grained UNEVEN or minute CONCHOIDAL.

* 2 Miſcell. Auſtr. 148.

Fragments

Fragments 2.

Hardneſs 5. 2. Specific Gravity 6,0269 BRISSON 5, 50. BINDHEIM.*

Streak and Powder ORANGE YELLOW.

Does not effervefce with Acids. The Vitriolic while cold, fcarcely or but flowly affects it. It refufes to unite, but not to diffufe itſelf in the Nitrous whether hot or cold. But the Marine, even without heat, fenſibly attacks it, and difſolves about 1/2 of its weight; if heated an effervefcence is perceived ariſing from the production of Oxymuriated Acid.

Treated with the blow-pipe on Charcoal it decrepitates, a ſmall proportion of the Lead is reduced but the greater part of it remains a black ſlag, which to Borax gives a graſs green colour paſſing into the leek green.

If mixed with $\frac{1}{2}$ of its weight of Charcoal and projected into a red hot crucible, it inflames by reafon of the pure Air. BINDHEIM.

By the Analyſis of Mr. BINDHEIM it contains, 60 per cent. of Lead, 11,66 of Molybdenous Acid. 5,66 of Nickel, a ſmall proportion of Copper and Cobalt, 1 of Calx of Iron, 5 of Air and Water and 4 5 of Silex.† The Molybden however ſeems to me to be only in the ſtate of a Calx.

But according to Mr. MAQUART it conſiſts of 35 per cent. of Lead, 57 Oxygen, $2\frac{1}{2}$ of Iron

* 4 Berl. Beob. 291.

and

and 2 f Argill. The former determination feems to me the moft accurate. The Molybdenic Calx is known to communicate a yellow colour to Lead. 1 Chym. Ann. 1794. 245. and a green to Borax, but here the Molybdenous Acid is not combined with the Lead.

It feems to be a Minium fuperfaturated with Oxygen and mixed with Molybdenic Calx and other Metallic Calces.

SPECIES IX.

Mineralized by Sulphur.

Of this we may diftinguifh four families, Common Galena, Compact Galena, Black Lead Ore, and Blue Lead Ore.

FIRST FAMILY.

Common Galena.

Its colour is either light or dark bluifh, that is LEAD GREY, fometimes Iridefcently variegated, blue and red, or verging on the green.

It is found maffive, diffeminated, invefting, fpecular, botryoidal, tuberofe, ftalactitic, tubular, cellular, corroded, interwoven, &c. or cryftalized in cubes, fometimes with truncated edges, or Hexahædral prifms, or double quadrangular pyramids, the fummits, fides and edges blunted, or in fix fided tables, &c. middle fized or fmall, and generally with fmooth furfaces.

Luftre

Luſtre, 3. 2. Metallic. Tranſparency, 0.

Fracture, plane, or curved FOLIATED, ſometimes broad, and long or ſhort STRIATED, ſometimes narrow and divergingly STRIATED.

Fragments moſtly quadrangular and of different ſizes; preſents GRANULAR, ſometimes curved LAMELLAR diſtinct concretions, fine or coarſe, rarely COLUMNAR.

Hardneſs from 5 to 7, rarely 8, or 9 from Pyritous or Quartz particles inviſibly intermixed. brittle.

Specific Gravity 7,587 BRISSON. 7,290 GELLERT. And of the Galenas of DERBYSHIRE, from 7,051, to 7,786 WATSON; nay he found one ſo low as 6,565.* I found that of the ſpecimen 2737, O. which is STRIATED to be 7,448. The heavieſt are the beſt.

Gives a bluiſh grey ſtreak of a Metallic Luſtre. Sometimes ſtains the fingers.

Effervesces both with Nitrous and Marine Acid.

In a crucible it melts eaſily into a yellowiſh ſlag and ſome Lead is commonly found reduced, and ſo much the more as the Ore is more Pyritous, but MERE IRON renders it refractory. 2 BERGM, 495.

Before the blow-pipe on Charcoal it decrepitates, but melts eaſily with a Sulphurous ſmell, part ſinks into the Charcoal; if alternately heated and cooled it will at laſt vaniſh and leave its Silver, if it contains any. BERGMAN, 493. For a more particular account ſee ENGESTROM in CRONSTEDT, p. 302.

* 3 Watſon, 211 and 212.

Lead enters into this Ore generally in the proportion of from 45 to 83 per cent. The Sulphur is to the Lead in the proportion of 16 to 83 nearly. But the Lead commonly contains Silver in the proportion of from [illegible] to [illegible] The Ores that have most lustre are said to contain most Silver, those that have least lustre contain most Iron, unless the want of lustre proceeds from decay.

Lead in GALENA is in its metallic state; for the Ore may be reduced by Alkalis alone without any phlogistic matter.

This Ore is said, sometimes to contain Zinc, or Regulus of Antimony. The Zincky Ores are said to be greyer than other Ores.† The Striated Ores are those that are said to be Antimonial.

Mr. LAUMONT found traces of the Phosphoric Acid in some of those of BRITTANY.

It is the commonest of all the Lead Ores.

To this we may annex the VERY LIGHT GREY ORE which RUPRECHT calls SILVER GLANZ, which contains 14 per cent of Silver, and also Gold with the Lead. It is generally found disseminated, rarely in cubes. Lustre 4. Fracture, FOLIATED, &c.

SECOND FAMILY

COMPACT GALENA.

Bley Schweif, of Werner.

Its colour is Lead grey sometimes paler or bluer, or inclining to the steel grey.

Found massive, in nodules, investing, and specular.

† 1 Born Phy. Arbeit, 43

External

External Luſtre, 2. 3. Internal. 0. 1. 2. Tranſparency, 0.

Fracture, COMPACT moſtly EVEN, or inclining to the flat CONCHOIDAL, ſeldom diſcovers ſtriæ, or inclines to the FOLIATED, ſometimes in the groſs SLATY

Fragments indeterminate, and preſents no diſtinct concretions.

Hardneſs from 6 to 8. Specific Gravity from 6,886 to 7,444 GELLERT. I found that of the ſpecimen 2753, O. to be 5,052. And that of the ſpecimen 2754, O. to be 4,013. but then this viſibly contains ſtony particles. That of the ſpecimen 2757, O. is 4,319

Streak brighter Lead grey and metallic. Often feels ſomewhat greaſy, and ſtains the fingers. Effervеſces with Nitrous Acid.

Hence we ſee that in luſtre, fracture, fragments, and Specific Gravity it differs much from the former family. However it is ſaid to contain no Silver.* but often Iron and Zinc,

The connexion it may often have with the Plumbiferous Silver Ore which contains ſo large a proportion of Lead, ſhould be noted.

Before the blow-pipe it does not decrepitate ſo ſtrongly as the former family, but melts eaſily and is reduced on Charcoal with a Sulphurous ſmell.

* Suckow Mineral, 339.

THIRD FAMILY.

Blue Lead Ore.

Blau Bleyerz, of Werner.

Its colour is intermediate between the Indigo Blue, and the Lead Grey, ſometimes inclining to Black.

Found maſſive, or cryſtalized in thick or ſlender 6 ſided priſms, divergingly bundled together, the ſurface often rough and coated with brown Iron Ochre.

External Luſtre, 1. 2. Internal, 1. Metallic. Tranſparency, 0.

Fracture, COMPACT, fine grained UNEVEN or EVEN.

Fragments indeterminate.

Hardneſs, 6. Specific Gravity, 5,461. GELLERT.

Streak brighter.

Before the blow-pipe it melts eaſily with a low blue flame and Sulphurous ſmell, and is eaſily reduced.

NOTE. ABBE WUFFEN remarks that thin Tranſparent Lamellæ of the white Lead Ore ſometimes appear bluiſh grey like ſcaly Iron Ore, becauſe they cover a browniſh black ſubſtance, or are obliquely inſerted in it.* It is very rare.

* 2 Miſcell. Auſtr. 271.

FOURTH

FOURTH FAMILY.

Black Lead Ore.

Schwarz Bleyerz of Werner.

Light or deep black, often with some streaks of red.

Found massive, disseminated, Cellular, Stalactitic or crystalized in small or minute hexahædral prisms, generally truncated, and often so implicated as to be difficultly distinguished.

External Lustre, 2. 3. Internal, 2. 1,5 Metallic. Transparency, 0.

Fracture, UNEVEN, or IMPERFECTLY CONCHOIDAL or intermediate between both.

Hardness from 5, 6. brittle. Specific Gravity, 5,744, BRISSON 5,77, GELLERT.

Streak light bluish grey.

Before the blow-pipe it decrepitates, but melts easily and is reduced.

By the experiments of Mr. LAUMONT it appears that this Ore consists chiefly of Sulphurated Lead arising from decaying Galenas, and the red part from the brownish red Phosphoric Ore. For from the black prisms he extracted Sulphur, and from the red part, Phosphoric Acid.*

Galenas appear to me to decay from super oxygenation.

* 30 Roz. Jour. 383.

Of

Of the Brown Lead Ore of Werner.

Its colour is reddiſh brown, or nut brown, ſometimes inclining to grey or black.

Found maſſive, and cryſtalized in oblong right angled four or ſix ſided or acicular, or capillary priſms.

External Luſtre, of the Cryſtals, 2. 1. Internal, 2. 1,5. Tranſparency, 2. 1.

Fracture, UNEVEN, or minute SPLINTERY.

Hardneſs, 5. brittle. Specific Gravity conſiderable.

Before the blow pipe it melts eaſily is not reduced but cryſtalizes into needles.

It occurs chiefly in BRITTANY and ſeems to be a variety of the third ſpecies already mentioned, containing Lead, Phoſphoric Acid, and ſome ſubſtance not yet determined which cauſes the acicular cryſtalization.

NOTE, What is called grey Copper Ore (FAHLERZ) both in CORNWALL and in the HARTZ, may alſo be deemed a Lead Ore, as that of CORNWALL contains about 49 per cent. and that of St. ANDREASBERG, 34 per cent. of Lead. The Plumbiferous Silver Ore alſo contains 48 per cent. of Lead.

CHAP.

CHAP. VIII.

MERCURY.

Its colour and Luſtre is that of poliſhed Silver. It remains liquid between 600° above, and 72° below the freezing point of water on FAHRENHEIT's ſcale.

Its Specific Gravity is 13,568 BRISSON, or nearly 13,6.

Eaſily ſoluble in Nitrous Acid, and alſo in the concentrated Vitriolic Acid ſtrongly heated.

The leaſt traces of Mercury in an Ore may be diſcovered by ſuſpending a poliſhed plate of Copper over it, when heated to redneſs, as globules of Mercury will adhere to the Copper.

SPECIES I.

NATIVE.

This is found in ſmall drops in various ſtones, Clays, or the various Mercurial Ores preſently to be mentioned. Heat often draws it into view.

SPECIES. II.

NATURAL AMALGAMA.

Its colour is Silvery white, or grey, rarely irideſcently tarniſhed.

Occurs

Occurs ſeldom maſſive, more commonly diſſeminated, inveſting, ſometimes cryſtalized in imperfect cubes, priſms, or pyramids, often in veins running thro' native Cinnabar.

Luſtre, 2. 3. 4. Metallic. Tranſparency, 0.

Fracture UNEVEN, or flat CONCHOIDAL.

Sometimes brittle, ſometimes tough according to the proportion of Mercury principally when triturated. It creaks when cut.

HEYER remarked that ſome of theſe amalgams are more brittle than, conſidering the proportion of Mercury they contain, they naturally ſhould be, and that this brittleneſs proceeds from a minute portion of Argill * If rubbed on Gold, it tinges it white.

The metal which Mercury is moſt commonly amalgamated with is Silver, of which the amalgam contains above 20 per cent; and which may be ſeparated by mere heat, and conſequently by the blow-pipe.

SPECIES III.

MINERALIZED BY OXYGEN.

NATIVE PRECIPITATE PER SE, AND HEPATIC MERCURIAL ORE.

Quick-Silver Lebererz of Werner.

Of the Hepatic Ore, WERNER diſtinguiſhes two families, the COMPACT and the SLATY.

* 1 Chym. Ann, 1790, 39.

FIRST

FIRST FAMILY.

COMPACT.

Its colour is intermediate between the Lead Grey and dark Cochineal Red, fometimes fpeckled green or blue, from a mixture of Copper.

It occurs only Maffive, and often contains Native Mercury and Cinnabar, moftly imbodied in Stony Matter.

Luftre 1. 0. Metallic. Tranfparency 0. Fracture COMPACT nearly EVEN.

Hardnefs from 6 to 8. Specific Gravity 9,2301 BRISSON. 7,937 GELLERT. I found that of the Specimen 1907. O. to be 7,186. and of the Specimen 1908. O. to be 7,352. That of Artificial precipitate PER SE is 10,871 BRISSON. Some maffes however are found and worked, whofe Specific Gravity is fo low as 2,340 GELLERT. as the Mercury is eafily expelled by heat.

Streak DARK RED, Metallic and brighter.

It is the commoneft Ore in the Mines of IDRIA.

It is itfelf infoluble in the colourlefs Nitrous Acid, tho' the foreign matter that accompanies it is often foluble therein. But the Marine Acid heated diffolves it.

It yields from 20 or lefs to 78 per cent. of Mercury. The heavieft Ore is the beft. It generally contains Calx of Iron, and ftony matter, often Cinnabar and Native Mercury.

If fufficiently heated, the Mercury flies off.

SECOND FAMILY.

SLATY.

Its colour is intermediate between the dark Cochineal Red, and the Iron black.

Found Maſſive. In the ſlaty rifts its Luſtre is 2. 3. in the croſs Fracture 1. common, but verging on the Metallic.

Tranſparency 0. Its longitudinal Fracture thick and curved SLATY. Its croſs Fracture nearly EVEN.

Hardneſs from 6 to 7. Specific Gravity conſiderable.

Streak dark Red and brighter.

It is frequently nothing more than Bituminous Marlite or Shale impregnated with Precipitate PER SE, as appears by its diſſolving in Marine Acid, and refuſing to do ſo in colourleſs Nitrous Acid.

Some think both theſe Species of Ore to conſiſt of a mixture of Cinnabar and indurated Martial Clay, but ſome alſo conſiſts of Native Precipitate PER SE.

SPECIES IV.

MINERALIZED BY THE VITRIOLIC AND MARINE ACIDS.

White or yellowiſh white, or Citron yellow, or greeniſh yellow, or greyiſh black, or black, theſe colours often meet in the ſame Specimen.

Fre-

Frequently mixed with green or blue Calciform Copper Ore and Cinnabar.

Found rarely maſſive, or diſſeminated; generally in cruſts ſcales or Nodules, or rounded, or cryſtalized in ſmall or minute Cubes, eight or ſix ſided Priſms, or four ſided Pyramids with truncated Angles, &c. often accumulated, or decayed, and then in a white or yellowiſh duſty form.

Luſtre of the white 2. 3. Pearly.

Tranſparency 2. 1. 0.

The yellow are chiefly Vitriol of Mercury proceeding from decayed Cinnabar, ſometimes the Vitriol of Mercury is found in the greateſt proportion in the group of both compounds, ſometimes the Muriated Mercury, but generally the former.

Before the blow-pipe they diſſipate.

SPECIES V.

Mineralized by Sulphur.

Of this we have two Families, Native Æthiops, and Native Cinnabar

FIRST FAMILY.

Native Æthiops.

Its colour is BLACK, or greyiſh black.

Found diſſeminated or ſeated on other Mercurial Ores.

Luſtre and Tranſparency 0.

Its conſiſtence looſe, it ſtains the fingers and is very heavy.

It is ſaid to have been found in the Territory of NASSAU. Nov. Act. Petrop. 1785. And at St. CHRISTIAN near PUSBERG. BEROLDING. 219. Specific Gravity 2,233 HAHN. Another Black ſubſtance containing either Æthiops or Cinnabar or Native Mercury is called Combuſtible or Bituminous Ore, as it conſiſts of Bitumen or Coal, impregnated with ſome or other of theſe ſubſtances, in the quantity of from 10 to 15, or 20 per cent. 2. RAAB. 200.

Sometimes the Oxygenated Ore, Species 3, when found in a ſtone abounding with Bitumen is ſo called.

SECOND FAMILY.

NATIVE CINNABAR.

Of this Mr. WERNER diſtinguiſhes two ſorts the dark Red, and the bright Red.

DARK RED.

Its colour is Cochineal RED, of different degrees of intenſity, ſometimes deſcending towards the Lead grey, ſometimes paſſing to the Carmine.

It occurs Maſſive, diſſeminated, inveſting, or in veins, or Cryſtalized in triangular Priſms or double quadrangular Pyramids, or Rhombs, the Cryſtals often diagonally ſtreaked, but commonly ſo ſmall or minute or implicated that their form is difficultly diſtinguiſhed.

Luſtre of the Maſſive 0. 1. 2. Of the cryſtalized 2. 3. Tranſparency of the Maſſive 0. Of the cryſtalized 2. 1. 3.

Fracture

Fracture, mostly FOLIATED, sometimes UNEVEN, rarely STRIATED or FIBROUS, which is remarkable, as that of the Artificial formed in the dry way is always Fibrous. Presents fine grained distinct concretions.

Hardness generally from 6 to 7. but sometimes only 3 or 4. and then stains the fingers.

Specific Gravity of a Triangular Prism from ALMADEN 10,1285 BRISSON. Of another Specimen 4,494, GELLERT. But this must be very impure, for I found that of the Specimen 1947, O. to be 7,786, and MUSCHENBR. found it in general 7,3 or 7,2, and once 6,188.

Streak dark red metallic.

Before the blow-pipe it dissipates with a blue flame and Sulphurous smell.

BRIGHT RED.

Commonly Scarlet, sometimes inclining to the Crimson, and thence passing to the bluish grey, but oftener to the light or orange yellow, particularly when decaying.

Found massive, disseminated, or in veins, or stalactitic, or dusty, or in minute Crystals.

Lustre, of the massive, 0. 1. Of the crystalized, 2. 3.

Transparency of the massive. 0. Of the crystalized, 1. 2. rarely, 3.

Fracture, COMPACT, UNEVEN, or fine EARTHY, sometimes FOLIATED, sometimes imperfectly fibrous.

Hardness

Hardneſs from 3 to 8. Specific Gravity 6,9022. BRISSON. 5,419. GELLERT.

The ſofter ſorts ſtain the fingers, and ſo do the harder when wetted.

Streak RED Metallic.

Before the blow-pipe it diſſipates like the former.

Baron BORN mentions a tranſparent Cinnabar Ore of a beautiful red and ſparry texture, found in the mines of IDRIA in 1789, which gives out an hepatic ſmell when rubbed. 2 RAAB. 394. it probably is of the ſort here mentioned; he ſuſpects the ſmell to proceed from a Calcareous Hepar, which does not ſeem improbable. 1 Chym. Ann. 1789. 316. ELHUYART aſſures us that Cinnabar may be decompoſed by Marine Acid, in long continued ebulliton.* However I found it inſoluble both in Marine and Nitrous Acid, in a boiling heat continued half an hour. Its beſt ſolvent is Aqua Regia, formed of three parts Marine Acid and one part of Nitrous Acid, as Mr. HILDEBRAND has ſhewn. Aqua Regia formed of three parts Nitrous and one part of Marine Acid Oxygenates the Sulphur and converts it into Vitriolic Acid.†

100 Parts of pure Cinnabar contain about 80 or 81 parts of Mercury, but it is ſeldom ſo pure, containing calx of Iron, or ſome earth, and hence it affords Mercury in various proportions according to its purity. Thus SCOPOLI found CINNABAR from CARINTHIA to yield 78 per cent. when other Specimens from SCHEMINTZ afforded

* 2 Bergb. 225. in note.

† 2. Chym Ann. 1792. 179.

but

[redacted]

but 34,4.* The Scarlet ſort (otherwiſe called Vermillion) is ſaid to contain more Sulphur than the darker ſort. BRISSON.

This ſort of Cinnabar is found in the hollows of compact brown Iron ſtone or brown Hæmatites.

THIRD FAMILY.

GREYISH BLACK.

This is ſaid to conſiſt of an intimate mixture of Cinnabar and Copper.

Its fracture is compact. When heated it decrepitates, the Mercury and part of the Sulphur flies off, the Copper remains, it contains a large proportion of Iron. Cronſt. and 1 Chym. Ann. 1784. 429.

* Dizzon. Vol. 3. p. 105.

CHAP.

CHAP. IX.

ZINC.

Its colour is intermediate between the filvery white and Lead grey, when tarnifhed it inclines ftrongly to the latter, or is rather bluer, and lefs black.

Luftre, 3. It is the moft malleable of the Semi-metals, and by compreffion may be reduced to thin plates, as Mr. SAGE has difcovered.

Fracture STRIATED paffing into the FOLIATED.

Hardnefs 6. is more brittle when hot, than when cold.

Its Specific Gravity, when pure and compreffed, is 7,1908. BRISSON. In its ufual ftate 6,862. BERGM. SCIAGR. I found that formed by fublimation and abounding in cavities, only 5,918.

Eafily foluble in acids, whether in a calcined or in a metallic ftate.

Heated, it melts as foon as it becomes red hot, namely at a higher heat than Lead but lower than Copper, then inflames and fublimes in flowers, at firft yellowifh, but white when cold or foon after. Its flame is bluifh greenifh white.

Before the blow-pipe it difficultly melts, as its furface becomes foon coated with a calcined cruft, however by a continued heat it is internally fufed, and a greenifh flame breaks out at intervals, while white flowers are fcattered around.

Mr. PILKINGTON in his account of DERBYSHIRE tells us that native Zinc has been found at BONSAL in the form of grey flat pliant needles, in the cavity of a Calamine. Thefe inflame when heated

heated to redneſs. Some circumſtances relative to the place and ſituation of this Calamine ſhould be aſcertained, before we can be certain that this Zinc is not a product of art. It is ſaid to be found native in the Iſland of Naxos. 1 Chym. Ann 1784.

SPECIES I.

MINERALIZED BY OXYGEN, WITH OR WITHOUT FIXED AIR.

Calamine. Galmei of Werner.

Of this Species we may diſtinguiſh three families, the looſe or friable, the COMPACT and the Striated.

FIRST FAMILY.

LOOSE OR FRIABLE, AND LAMELLARLY MIXED WITH IRON OCHRE.

Its colour is pure white, grey, or light yellow, from a mixture of Calx of Iron. Of a looſe conſiſtence and frangible betwixt the fingers like the ſecond family of the ſecond ſpecies of Lead Ores, but (tho' heavy) much lighter

Luſtre 0. Tranſparency 0. Fracture Earthy.

It ſometimes efferveſces with Acids, ſometimes not, like the Artificial flowers of Zinc, which BERGMAN found ſometimes efferveſcent ſometimes not. 2 BERG. 323. with dilute Vitriolic Acid it yields Vitriol of Zinc, and a ſmall proportion of that of Iron, if the red part be alſo diſſolved.

Heated to Redneſs it often (when pure) becomes yellow, but reaſſumes its colour on cooling.

Treated in a crucible with ⅛ of its weight of Charcoal, in a white heat, it burns with a greeniſh blue light undulating flame, and ſome flowers ſublime.

With Sulphurated Volalkali it does not blacken. The ſolubility of Ores of this ſpecies, in Vitriolic Acid, is another character that prevents miſtaking them for White Lead Ores.

The white does not contain Iron, but is pure Zinc.

It is frequent in CHINA and there called *Wohan*, or Ore of Tutenago.

The undulatingly veined with Brick red Iron Ochre, contains alſo a mixture of Calx of Zinc.

SECOND FAMILY.

COMPACT, LAPIS CALAMINARIS.

Its colour is greyiſh white, or yellowiſh grey, or ſmoke grey, or greyiſh brown, or browniſh red, or wax, or Ochre yellow. Theſe different colours often meet in the ſame ſpecimen.

The yellowiſh often become grey by expoſure to the air.

Found maſſive, diſſeminated, corroded, cellular, cavernous, ſtalactitic, nodular, branchy, tubular, dentiform, botryoidal, lamellar, and commonly coated, overlaid, or mixed with Calx of Iron.

Luſtre o. Tranſparency o.

Fracture, compact, moſtly UNEVEN or EARTHY, but often alſo SPLINTERY, ſometimes alſo EVEN, in the groſs ſometimes ſlaty, rarely CONCHOIDAL

[redacted]

CHOIDAL. The white or grey moſtly conſiſts of lamellar ſomewhat incurvated or undulating diſtinct concretions. The browniſh red Nodular Ore alſo ſometimes preſents ſimilar lamellar concretions, but theſe belong to the next family?

Hardneſs from 4 to 8. rarely 9. Specific Gravity of a ſpecimen in my Cabinet 2,585. but ſome are much heavier. That of LESKE. O. 2997 is 3.674. and that of 2998. O. is 4,919. but they are evidently ferruginous. Sometimes magnetic.

Before the blow-pipe if quickly heated it decrepitates but does not melt, but becomes either whiter, or yellow.

Sometimes Efferveſces with Acids (as all thoſe of my Cabinet,) but many ſpecimens do not, though ſoluble therein. The former loſe by Calcination about one third or more of their weight.

Zinc is contained in theſe Ores in various proportions, from $\frac{1}{8}$ to $\frac{1}{4}$ by Mr. MARGRAFF's experiments 1. MARGR 91, but ſome contain much more.

In a ſpecimen of yellowiſh white Calamine which did not efferveſce with acids, BERGMAN found 84 per cent. of Calx of Zinc, 3 of Calx of Iron, 12 of Silex, and 1 of Argill. When heated it loſt no weight. 2 BERGMAN. 321, 322.

In other reſpects this family agrees with the former.

Weſtrumb extracted by Diſtillation from 100 parts of this Calx, 3,1 of Water, 3 of fixed air, and 3,4 of OXYGEN. 2 WESTR. 1 HEFT. 136. But as it was ſtill a Calx, it is plain it muſt have contained more OXYGEN.

THIRD FAMILY.

STRIATED. ZINC SPAR OF SOME.

Snow white, whitiſh grey, or greeniſh grey, or bluiſh grey, or greeniſh yellow, or ochre yellow, or greeniſh red, or greyiſh or whitiſh yellow, or reddiſh brown, or garnet red, and ſome ſay green, or blue, but theſe are very rare.*

Occurs maſſive, diſſeminated, ſtalactitic, but more commonly nodular, botryoidal, or rounded, or overlaying, or cryſtalized, in ſmall 6 ſided priſms, or in three ſided pyramids, or in quadrangular, or hexangular tables accumulated, with or without bevilled edges, or cuneiform, &c. The cryſtalized are often (though improperly) called ZINC SPAR.

LUSTRE 2. 1. Common. Tranſparency 2. 1. 3.

Fracture, commonly divergingly or ſtellularly STRIATED, ſometimes paſſing into the FOLIATED, more rarely fine grained UNEVEN.

Hardneſs from 7 to 9. brittle. Specific gravity of a ſpecimen of greeniſh grey cryſtals 3,523'. BRISSON.

Some effervefce with acids, ſome not, though ſoluble therein as to the zinky part.

With Sulphurated Volalkali they do not blacken.

Decrepitate and whiten when rapidly heated. They often reſemble Zeolytes, but Zeolytes ſcarce ever decrepitate, nor are they ſoluble in the acetous acid, and are much lighter.

Before the blow-pipe they do not melt, but when cold become whiter.

* Ferber N. Acta Petrop. 1785. 271.

If

If heated to rednefs and in large lumps they often Phofphorefce, fo alfo when heated white with ¼ their weight of Charcoal emitting a greenifh flame.

In an Aerated fpecimen of this family from HOLYWELL, Mr. BERGMAN found 64 per cent. of Calx of Zinc, 28 of Fixed Air, and 6 of Water. 2 BERGM. 224. In another alfo from HOLYWELL, MARGRAFF found 60 per cent. of Zinc. PELLETIER in a fpecimen of the ftriated kind which gelatinated with Acids, and therefore paffed for a Zeolyte, found about 52 per cent. of Silex, 36 of Calx of Zinc, and 12 of Water and no Air. 20 ROZ. Journ. 428.

KLAPROTH in another of a rounded fhape and fibrous fracture, which gelatinated with Acids, and paffed for Phofphorite, found 66 per cent. of Calx of Zinc, and* 33 of Silex.

This Ore often ftrongly refembles the Sparry Iron Ore, yet by the above characters it may eafily be diftinguifhed from it. It feldom or never contains mild calx, which the other always does.

SPECIES. II.

MINERALIZED BY SULPHUR, WITH IRON.

BLENDE

Of this Mr. WERNER diftinguifhes three families, the yellow, the brown, and the black.

* 1 Chym Ann, 1788, 391.

FIRST

FIRST FAMILY.

Yellow.

Gelbe Blende of Werner.

Its proper colour is Sulphur yellow, but it often paſſes into the greyiſh, or greeniſh yellow, or Oilve green, often browniſh red.

Found maſſive, groſly or minutely diſſeminated, or cryſtalized in ſomewhat rounded octohædrons, or four ſided pyramids, moſtly indiſtinct and middle ſized or ſmall; very rarely in perfect hexagonal priſms.*

Luſtre 3. 4. 2. Metallic.† Tranſparency, 2. 3. 4.

Fracture foliated, the lamellæ variouſly directed, preſents groſs or minute, or fine grained diſtinct concretions.

Hardneſs from 6 to 8. Specific Gravity 4,044 Gellert, of a ſpecimen of my own Cabinet 4,067.

Streak yellowiſh grey, or greeniſh grey, not metallic, its powder alſo is pale yellow.

It is generally mixed with, and paſſes into the next family.

It ſcarcely efferveſces with Acids, unleſs theſe be heated, tho' ſlowly ſoluble therein.

* Ferber N. Act. Petrop. 1785, 274

† Some deny the luſtre of this Ore to be metallic, or even that of any Blende, which to me ſeems very ſurpriſing as all thoſe to whom I ſhewed ſpecimens of them (except a few of the red and black) concured in concluding them to be metallic from their aſpect. In certain portions, it is true their luſtre is obſcured, but enough appears to determine any one to pronounce it to be metalic.

Decrepitates

Decrepitates when heated, whitens when treated with the blow-pipe, ejecting white flowers. Borax does not affect it.

It frequently Phophoresces when lightly scraped or triturated.

Mr. BERGMAN found a specimen of the phosphorescing kind he essayed to contain 64 per cent. of Zinc, 5 of Iron, 20 of Sulphur, 6 of Water, 4 of Fluor Acid, and 1 of Silex. 2 BERGMAN, 347.

The greyish yellow Blende is said to contain 24 per cent. of Zinc, the remainder Galena and Petrol.

SECOND FAMILY.

BROWN.

Braune or Red Blende of Werner.

Light or dark brown, or brownish black, or reddish brown, or brownish or hyacinth red, sometimes iridescently tarnished yellow and blue and greenish.

Occurs massive, grossly or minutely disseminated, or crystalized in right angled quadrangular prisms acuminated, the acuminating planes resting on the edges of the planes of the prism, or in Triangular Pyramids, with or without truncated edges, mostly indistinct. Commonly middle sized.

External Lustre 2. 3. Internal 2. 3. 0. Metallic, except that of the red which is common.

Transparency 0. 1. 2.

Fracture

Fracture, more or leſs perfectly FOLIATED, commonly plane, rarely curved, the lamellæ variouſly directed, with fine or coarſe grained concretions.

Hardneſs from 7 to 8. Specific Gravity from 3,77 to 4,048 GELLERT. I found that of the Specimen LESKE O. 2070 to be 3,963.

Streak, grey, or reddiſh, or yellowiſh grey, not metallic. The powder is browniſh grey.

It is affected by Acids as the former family.

The ſpecimen tried decrepitated when heated, and in a ſtrong heat whitened. By the flame of the blow-pipe it gives white flowers, but does not melt with Borax. That examined by BERGMAN did not decrepitate probably becauſe ſlowly heated. Many of this family Phoſphoreſce when ſcraped or triturated.

In a reddiſh brown Ore of this ſort BERGMAN found 44 per cent. of Zinc, 17 of Sulphur, 24 of Silex, 5 of Iron, 5 of Water, and 5 of Argill. 2 BERGMAN 333. It is evident the Silex and Argill are merely adventitious. It is this quantity of foreign ſubſtance and water that renders the Specific Gravity of many of theſe Ores ſo low.

The Red Blendes of HUNGARY ſeem to contain not only Zinc, Iron, and Auriferous Silver, but alſo Lead and Mangancſe.*

* Born Phy. Arbeit 2 Stuck, 87.

THIRD

[redacted]

THIRD FAMILY.

Black.

Schwartz Blende of Werner. Pechblend, of Cronstedt.

Pseudo Galena of many.

Dark black, or brownish black, often passing into the blood red, or bluish black, or iridescently tarnished blue, the tips of the Crystals often blood red.

It is found massive, grossly or minutely disseminated, or crystalized in middle sized single three sided or double four sided pyramids, with blunted edges, sometimes with conically convex planes; or Acicular and small, commonly indistinct.

Lustre 2. 3. 1. Common or metallic. Transparency 0. 1. except of the Red parts which is commonly 2.

Fracture, Foliated, the lamellæ variously directed; sometimes even. Fragments 3.

Hardness 8. Specific Gravity 4,1665 Brisson. From 3,930, to 3,967 Gellert.

That of Hungary which is Auriferous has its Specific Gravity 5,398.*

Streak, reddish, brownish, or grey, and in some positions relative to the light, metallic. The powder brownish black. Wetted its lustre is much obscured.

Not magnetic, neither crude nor calcined.

* Born Phy. Arbeit. 2 Stuck. 86.

Decrepitates when heated, but does not melt, nor is it affected by BORAX. On charcoal it ſmokes and depoſits white flowers, and yellow if it contains lead.

Acids even while cold, act on it with effervescence.

As it has much the aſpect of Galena, and yet contains little or no lead, it has been called PSEUDO GALENA; though BERGMAN extends this term to all the Blendes.

In an Ore of this ſort, which had not the metallic luſtre from DANNEMORA Mr. BERGMAN found 45 per cent. of Zinc, 29 of Sulphur, 6 of Lead, 9 of Iron, 6 of Water, 4 of Silex, and 1 Regulus of Arſenic. 2 BERGMAN. 332.

In another which was bluiſh black and had the metallic luſtre from BOVALLON,* he found 52 per cent. of Zinc, 26 of Sulphur, 4 of Copper, 8 of Iron, 6 of Silex, and 4 of water. 2 BERGMAN. 335.

In all he juſtly ſtates the metals, as in their metallic ſtate, though his Syſtematic notions induce him to judge them VERY SLIGHTLY dephlogiſticated. But all the Phœnomena atteſt in favour of their perfect metallic ſtate, as Mr. BRUEL has ſhewn. 1 Chym. Ann. 1791. 392. And the quantity of Sulphur in theſe Ores clearly ſhews it is united, not only to the Iron, and Copper (which could not take up ſo much) but alſo to the Zinc.

It is remarkable that all theſe Blendes ſhould contain ſo much water.

* Bergman does not mention its colour but Cronſtadt does. §. 229

The

The black Blende of Hungary beſides Zinc and Iron contains alſo Manganeſe, and a ſmall proportion of Gold. It has alſo the ſingular property of giving out hepatic air when treated with the Nitrous Acid.

NOTE. Theſe Sulphurated Ores often contain Silver, though Mr. BERGMAN found none in thoſe he examined. It is eaſily detected in Vitriolic or Nitrous Solutions, by the addition of the Solution of common Salt.

Per Engeſtrom Blendes cannot be eſſayed by the blow-pipe, however the white flowers they throw up furniſh an indication not to be neglected.

Vitriol of Zinc conſtitutes a third ſpecies, but has been already mentioned among the ſaline ſubſtances.

CHAP. X.

ANTIMONY.*

Its colour is white, yet with a ſhade of grey.

Luſtre 3. Fracture Foliated, the lamellæ placed in irregular directions, often 4.

Hardneſs 6,5. exceeding brittle. Specific Gravity 6,702 BRISSON. or from 6,624 to 6,805 GELLERT. or 6,860. BERGMAN.

It deflagrates and effervefces with Nitre.

It melts at a ſomewhat higher heat than Zinc, but at a lower degree than Copper. If ſuffered to cool ſlowly it tends to cryſtalize and its ſurface acquires a ſtellular appearance.

In a higher heat it evaporates in the form of a grey ſmoke, which when condenſed forms white acicular cryſtals called Argentine Calx of Antimony. Its calces impart a Hyacinth colour to Borax, which in a higher continued heat diſappears.

The Nitrous Acid with the aſſiſtance of heat calcines this ſemi-metal, if dilute it ſlowly diſſolves, but difficultly retains it in ſolution.

Neither is the concentrated Marine Acid intirely inert with reſpect to it; but its beſt ſolvent is Aqua Regia, in which the Marine Acid predo-

* With the Moderns I denote by this name, what was formerly called REGULUS OF ANTIMONY, and what was anciently called Antimony I call SULPHURATED ANTIMONY

minates,

minates, as ſeven parts Marine Acid and one of Nitrous Acid; from this alloy it is precipitable by the affuſion of water. But the Muriatico Vitriolic Acid of Wenzel which alſo diſſolves it, will bear a ſlight affuſion of water. His Nitro Vitriolic Acid alſo diſſolves it. By Sulphurated Volalkali, it is precipitated dark red.

SPECIES. I.

NATIVE ANTIMONY.

This was firſt diſcovered in SWEDEN by that eminent Metallurgiſt Dr. SWAB, but its reality was ſtrongly conteſted, untill MONGEZ the younger again aſcertained its exiſtence in the Mines of Allemont, by the cleareſt and moſt convincing experiments.

Its colour is intermediate between that of Tin and that of Silver.

Found Maſſive, and Reniform.

Luſtre, 3. Metallic. Fracture, plane rarely curved FOLIATED, the lamellæ diſpoſed as in the artificial.

Hardneſs 6. Specific Gravity not given but ſaid to be conſiderable.

It deflagrated and effervefced with Nitre.

Treated with a blow-pipe it melted and eaſily evaporated, depoſiting a white calx like the artificial, but giving ſome ſigns of Arſenic. With Acids alſo he found it to have the ſame relation as the artificial.

It contains about 3 or 4 per cent. of Regulus of Arſenic. 23 Roz. Journ. 67.

It

It was long imagined that a ſingular ſubſtance containing Gold, found in the Mine Faceb ey in HUNGARY was native Antimony. But Mr. MULLER by a ſeries of judicious experiments clearly proved that it is a ſubſtance of a different nature, whoſe properties are competent to no other known ſubſtance, and therefore moſt probably a new ſemi-metal, of which we ſhall treat in the ſequel.

The property of this Ore of Amalgamating with Mercury was long thought an objection to its claim to be real Antimony, but the antimonial Silver Ore diſcovered by SELB which alſo AMALGAMATES, evidently ſhews this metal is not, when free of Iron incapable of Amalgamation. and alſo the experiments of MARGRAF.

SPECIES. II.

SULPHURATED ANTIMONY.

Gran Spies Glaſs erz. of Werner.

Of this Species Mr. WERNER diſtinguiſhes three families. The Compact, the Foliated, and the Striated; they have all the ſame or nearly the ſame Chymical properties.

All of them are readily fuſible by the blow-pipe on Charcoal, with a Sulphureous ſmoke and emiſſion of white flowers, bubble while in fuſion, and at laſt diſappear, depoſiting the flowers in the form of duſt which being melted afford a reddiſh brown Glaſs.

In

In a very ſlow fire and open crucible the Sulphur alone evaporates, leaving if pure, only a grey calx, with a loſs ot about 22,5 per cent. This calx retaining a little Sulphur is alſo fuſible into a reddiſh brown Glaſs.

In Sulphurated Antimony the proportion of Sulphur and Reguline Antimony, are to each other nearly in the proportion of 26 per cent. of Sulphur to 74 of Antimony, according to Mr. BERGMAN.*

All theſe Ores contain a large proportion of ſtony matter, moſtly Quartz diffuſed thro' them.

Nitrous Acid has no effect on it untill heated, and then Calcines the Reguline part. The Marine Acid extracts hepatic air, but does not exert any diſſolving power untill heated and then but ſlowly.

Aqua Regia formed of one part Nitrous Acid and four of Marine is its moſt effectual ſolvent

From theſe ſolutions water precipitates the regulus, WHITE or grey, and Sulphurated Volalkali RED.

FIRST FAMILY.

CÓMPACT.

Dichtes Grau Spiez glaſs erz of Werner.

Bluiſh grey or ſteel grey, when tarniſhed Irideſcently variegated blue or purpliſh.

Found maſſive, or diſſeminated.

Luſtre 1. 2. Metallic. Tranſparency 0.

* Bergm. 167. 179.

Fracture, ſmall grained UNEVEN.

Hardneſs from 6 to 7. Sometimes it gives fire with ſteel by reaſon of the quartz diffuſed thro' it.

Specific Gravity of the ſpecimen of LESKE, O. 2999 which contains quartz is 4,194.

Streak, grey metallic and brighter. Powder black, dull and earthy, Slightly ſtains the fingers.

The ſpecimen above-mentioned containing much quartz decrepitated when heated, much of the Sulphur evaporated and left a yellowiſh compacted maſs.

Before the blow-pipe it melts eaſily, at firſt giving a blue flame and Sulphurous ſmell and depoſiting a white calx on the coal.

It occurs more rarely than the ſubſequent Families.

SECOND FAMILY.

FOLIATED.

Light Steel Grey.

Occurs maſſive, or diſſeminated.

Luſtre 3. 4. Metallic. Tranſparency 0.

Fracture, thick or thin, plane GRANULARLY FOLIATED, rarely curved, frequently paſſes into the STRIATED.

Hardneſs, 6. Specific Gravity of a ſpecimen from HUNGARY, of my Cabinet 4,368. which ſtains the fingers.

Streak and powder, as of the former family.

It melts nearly at the ſame heat as Lead, and cooling ſlowly forms ſome Acicular Cryſtals.

THIRD

THIRD FAMILY.

STRIATED.

Dark Steel grey, or light bluiſh grey, when tarniſhed dark blue, or Irideſcently variegated purple; ſome ſpecimens from HUNGARY ſaid to have ſuffered from the heat of adjacent pits are beautifully variegated blue, purple, green, and pale yellow, in Zones.

Found Maſſive, diſſeminated, or cryſtalized, in four ſided priſms, or ſix ſided ſlender and Acicular Pyramids; commonly faſcicularly, ſometimes confuſedly arranged.

Luſtre 3. 2. Metallic. Tranſparency 0.

Fracture narrowly and divergingly STRIATED, or ſuperincumbently STRIATED or BROAD STRIATED and FOLIATED. Hardneſs 6. yet it often ſtrikes Fire with Steel, by reaſon of Quartz diffuſed thro' it.

Specific Gravity from 4,1327 to 4,516. BRISSON. 4,229. GELLERT. and of one of my collection 4,440.

Streak as of the former families, powder greyiſh-black.

Before the blow-pipe it melts as the former.

SPECIES III.

Mineralized by Sulphur, with Arsenic.

Plumose Antimonial Ore.

Federerz of Werner.

Its colour is ſteel or bluiſh-grey, or, when tarniſhed, brown or greyiſh-black, or Variegated.

It is generally found reſting on ſtones or other foreign foſſils in the form of brittle Capillary or Lanuginous Cryſtals, often ſo minute as to be diſcerned only by a Magnifier, and confuſedly heaped or interwoven, and ſo brittle as to ſtain the fingers.

Luſtre 1. 1,5. Semi-Metallic.

Beſides Arſenic it alſo contains a ſmall proportion of Silver, about 3 or 4 per cent.

No juſt Analyſis of it has as yet been given.

Before the blow-pipe it emits a ſmoke which depoſits on the Charcoal a whitiſh and yellowiſh powder. The Reſiduum melts into a black ſlag.

SPECIES IV.

Red Antimonial Ore.

Roth Spieſs Glazerz of Werner.

Light or dark Cherry Red, or Mordore, or Purpliſh Red.

It is generally found in cavities or rifts of other Antimonial Ores, cryſtallized in delicate needles or

or capillary often diverging as from a common center, ſomewhat flexible yet brittle, rarely Maſſive.

Luſtre 2. Silky. Tranſparency 0.

Its Specific Gravity is ſaid to be 4,700.

The nature of this Ore is not yet accurately determined. Mr. SAGE thinks it a natural Kermes.

Before the blow-pipe it melts eaſily, and evaporates with a Sulphureous ſmell.

SPECIES V.

MURIATED ANTIMONY. WHITE ANTIMONIAL ORE.

Weiſs Spies Glaſſerz of Werner.

Colour is pale-yellowiſh or greyiſh-white.

Found ſeldom Maſſive, generally in right angled quadrangular tables, or Lamellæ, or in Acicular Cryſtals grouped like Zeolytes, or in priſms.

Luſtre 3. 2. 1. nearly Metallic. Tranſparency 2.

Fracture FOLIATED.

Treated with the blow-pipe on burning Coals, it decrepitates, but when powdered and ready to melt, it evaporates and leaves white flowers around, which inſtead of Vitrifying, evaporate like Artificial Muriated Antimony, which alſo has the property of cryſtalizing in tables when precipitated by a large proportion of Water. With Acids it has the ſame relation as Sulphurated Antimony, but leaves no Sulphur behind when diſſolved in Aqua Regia.

Betwixt two Coals it is reducible to a Metallic State.

It is found in the Mines of ALLEMONT, and near PRZIBRAM in BOHEMIA.*

It is the white Calx of Antimony discovered by MONGES which I mentioned in my first Edition, p. 325.

ANTIMONIAL OCHRE.

Its colour is straw or lemon yellow.

Generally found incumbent on grey Antimonial Ore.

Lustre 0. Hardness from 4 to 5. in other respects it has an Earthy appearance.

KARSTEN supposes it a Calx of Antimony. Future experiments must decide.

Before the blow-pipe it does not melt, but Volatilizes and deposits a white powder. With Borax it effervesces and is partially reduced.

It is probably the yellow Antimonial Calx mentioned by SAGE. Mem. Par. 1787. p. 247. which he says is soluble without effervescence in Nitrous Acid, becomes reddish-brown when heated on burning Coals, and melts into Vitreous Globules analogous to Crocus Metallorum. It seems to contain Iron.

SUPPOSED PHOSPHORATED ANTIMONY.

Its colour is white, reddish YELLOW, or BLACK when tarnished.

* 1 Chy. Ann. 1787. 334. and 1 Chy. Ann. 1789. p. 9. per Klaproth.

Found

Found in Acicular Cryſtals $\frac{1}{12}$ of an Inch long at moſt, and longitudinally Streaked in the Cavities of a vein of Sulphurated Antimony in SAVOY by Count RAZOMOUSKI. It is ſaid alſo to appear in the Shape of ſmall right angled four ſided tables.

Luſtre 2. That of the black is Metallic.

Flexible and eaſily cut.

With the blow-pipe does not inflame, nor remarkably ſmoke, yet is eaſily fuſible and leaves a greyiſh ſhining brittle ſlag including a ſilvery white button which he takes to be Metallic Antimony.

With Borax it gives a lead coloured button, or a reddiſh yellow pellucid glaſs.

Seven or eight parts Calx of Antimony with ten of Phoſphoric Acid afforded him ſimilar reſults.

However neither MORVEAU nor MARGRAF could obtain Cryſtals with this Acid and Antimony. 1 Chym. Ann. 1786, 291.

CHAP.

CHAP. XI.

ARSENIC.*

Its natural colour is white with a ſtrong ſhade of blue, but it quickly tarniſhes by expoſure to the air, becoming pale yellow, and at laſt greyiſh black.

Luſtre 3. Fracture FOLIATED. Hardneſs, 7. exceeding brittle.

Specific Gravity is ſaid by MUSCHENBR. to amount to 8,310. and alſo by BERGMAN. However it generally abounds in blebs, and hence perhaps BRISSON found it only 5,763.

Heated in open veſſels it evaporates before fuſion in the form of a white ſmoke with an Alliaceous ſmell; ſtrewed on burning coals, it gives a low bluiſh white flame and white ſmoke which extends to a diſtance; in cloſe veſſels it ſublimes without alteration and cryſtalizes.

Its calx alſo ſublimes with the ſame ſmell and white ſmoke, which no other Calx does.

The Vitriolic and Marine Acids do not attack it unleſs concentrated and heated, and this laſt even ſo, very ſparingly.

The Nitrous Acid alſo ſlowly unleſs heat be applied. Aqua Regia is its true ſolvent

Water in the heat of Ebullition long continued diſſolves about [illegible] part of its weight of Reguline Arſenic, and keeps it in ſolution in the loweſt degree of temperature as appears by Mr. HAHNEMAN's experiments. 1 Chym. Ann. 1788, 182. but then it appears to be oxygenated by decompoſing part of the water in that heat. Fat Oils alſo diſſolve it.

* By Arſenic I mean Regulus of Arſenic.

SPECIES

SPECIES. I.

NATIVE ARSENIC.

Scherben Coba't of Antient Writers.

Its colour is Steel Grey, or intermediate between the Tin white, and Lead grey, but ſoon turns greyiſh black by expoſure to the air.

Found, ſeldom maſſive, and ſtill ſeldomer diſſeminated, oftner botryoidal, kidney-form or in perforated tables, or ſtalactitic, corroded, ramified, bearing various impreſſions, &c.

Luſtre when recently expoſed to the air, 3. 2. When tarniſhed, 1. 0.

Fracture, compact, generally UNEVEN, EVEN, or FLAT CONCHOIDAL, rarely broad and divergingly STRIATED, often with thick or thin, plane or curved lamellar concentric diſtinct concretions.

Hardneſs from 7 to 8. brittle. Specific Gravity of the STRIATED 5,7249 BRISSON. Of the BOTRYOIDAL 3,0534 Ib. but here there muſt be a miſtake. I found that of the ſpecimen, O. 3215. whoſe Fracture is UNEVEN to be 5,670

Streak, bluiſh grey, brighter, Metallic. Powder dull and black.

It gives an Arſenical ſmell when ſtruck.

With reſpect to heat and acids, it is affected as the artificial.

Before the blow-pipe it immediately emits a white ſmoke, diffuſing even to a diſtance its peculiar ſmell, burns with a blue flame, and gradually vaniſhes, depoſiting a white powder.

It commonly contains a ſmall portion of Iron, and often of Silver, and ſometimes Gold.

SPECIES II.

Native Arsenic, alloyed with Iron.

Arsenical, Pyrites, or Marcassite.

Arsenickies, of Werner, Mispickel, of others.

Tin, rarely ſilvery white. When tarniſhed it becomes grey or yellowiſh, or irideſcently variegated blue, &c.

Found maſſive, diſſeminated, overlaying; or cryſtalized in ſmall or middle ſized acute angled quadrangular priſms, often imperfect, and collaterally or confuſedly concreted or connected together, or in octohædrons, &c.

Luſtre 3. 4. Metallic. Tranſparency 0.

Fracture, compact, generally the fine grained UNEVEN, ſometimes STRIATED or intermediate BETWEEN THE FOLIATED AND THE STRIATED,* preſenting either minute granular, or parallel or interſecting columnar diſtinct concretions.

Hardneſs from 9 to 1. Specific Gravity 6,5223. BRISSON. 5,753. GELLERT.

Gives an Arſenical ſmell when ſtruck.

Effervesces with nitrous Acid without the aſſiſtance of heat.

According to HENCKEL † and 2 BERGM. 279. It contains from to $\frac{1}{2}$ of its weight of Iron and little or no Sulphur. When heated moſt of the Arſenic flies off.

* As at, O. 32;0.

† Chap. 5 p. 165. of the French Edition in 4to.

The

The Marcaſite found near DUBLIN, called Iriſh Diamond is of this Species.

When thrown on burning Coals it gives a bluiſh flame, and leaves a reddiſh-blue Reſiduum.

Before the blow-pipe it gives a white Arſenical Smoke, which deſcends in the form of a white Calx, and leaves a reddiſh-brown Reſiduum.

SPECIES III.

ALLOYED WITH SULPHURATED IRON, AND OFTEN WITH SILVER.

Weiſſerz of Werner.

ARGENTIFEROUS ARSENICAL PYRITES.

Its colour is nearly the ſame as that of the former Species.

Seldom found Maſſive, commonly diſſeminated, or Acicular.

External Luſtre 1. 2. Internal 1, 5. Metallic. Tranſparency 0.

Fracture fine grained UNEVEN, often it ſeems to me MINUTE FOLIATED.

Hardneſs from 9 to 10. Specific Gravity of the Specimen O. 3245 which is not quite pure being mixed with Quartz, is 4087.

Gives an Arſenical ſmell when ſtruck.

Effervеſces with Nitrous Acid without the aſſiſtance of heat, and gives out Nitrous Air. With the Marine Acid heated, (which ſlowly acts upon it) it gives an hepatic ſmell.

It burns with a white flame, and leaves a reddiſh Reſiduum. Hence it evidently contains Sulphur and Arſenic. It often contains Silver, in

the proportion of from 10 or 12 per cent. to 1 or less.

It has been confounded with native or Arsenicated Silver, from which it differs in the proportion and even number of ingredients, as this besides Arsenic and Silver, contains also Sulphur and Iron. They differ also in Colour, Lustre, Fracture and Hardness.

The description given by Mr. MONNET in his Mineralogy, p. 283. of the Argentiferous Arsenical Pyrites found at GUADALCANAL in SPAIN, differs but slightly from this.

Its colour is yellowish-white. Lustre 2. 3. Fracture, curved FOLIATED.

Hardness such as to permit it to be easily cut like Lead. Its streak Metallic.

Easily fusible and contains about $\frac{1}{200}$ of Silver with a little Iron.

I have not found mention of it by any other writer. By solution in Aqua Regia the Silver will be precipitated in the form of LUNA CORNUA.

SPECIES IV.

MINERALIZED BY OXYGEN.

NATIVE CALX OF ARSENIC.

It is found in two states, Loose or Indurated.

LOOSE.

Dusty, Mealy or Earthy like common white Arsenic. Its colour dull white, or grey or reddish, greenish, or yellowish WHITE, or greyish-black,

black, feels harſh and gritty. (The grey or blackiſh-grey is often but ſlightly Oxygenated) inveſting or ſeated on other Ores.

INDURATED.

White, grey or Reddiſh, or blackiſh-grey, or coloured as the foregoing.

Found Maſſive, or Stalactitic with a tuberoſe or botryoidal ſurface, or cryſtalized in ſmall indiſtinct trigonal or double quadrangular Pyramids, or in quadrangular implicated Lamellæ, or Capillary.

Luſtre 1. 2. Common. Tranſparency of the cryſtalized, 2. Of the Maſſive 1. 0.

Fracture, EARTHY, or ſomewhat FIBROUS, or tending to the FOLIATED.

Hardneſs 6. brittle. Specific Gravity 2,4775. BRISSON. But I ſuſpect this to be a miſtake. BERGMAN found it 3,709. and I found that of another of my Cabinet 3,700. That of the Artificial is laid by BERGMAN at 4,000.* Heated, it ſublimes without inflaming, but requires a a ſtronger heat than Reguline Arſenic, in ſmall doſes it gives a yellow tinge to Borax.

Soluble in dilute and hot Nitrous Acid, without effervefcence, or at leaſt a weak effervefcence proportioned to its ſtate of Oxygenation. And ſtill more ſo in Marine Acid, and Aqua Regia.

Water diſſolves $\frac{1}{80}$ of the weight of it in the Temperature of 60°. or $\frac{1}{15}$ at 212°. of which it retains the greater part when cold.

According to HENCKEL this Calx is often found in Clays and blue Marles and may be diſtinguiſhed

* 2 Bergman 263.

guiſhed by its ſmell when thrown on burning Coals, or by Lixiviation in boiling water.

SPECIES V.

Mineralized by Sulphur.

Of this there are two families, Orpiment and Realgar.

FIRST FAMILY.

Orpiment. *Gelbes Rauſchgelb of Werner.*

Its colour is of various ſhades from the Lemon or Orange to the Sulphur yellow.

Found Maſſive or diſſeminated, ſeldom inveſting; or cryſtalized in imperfect Octohædrons, ſmall or minute quadrangular priſms, generally ſo implicated as not to have their ſhape diſtinctly diſcerned.

Luſtre 2. 3. Waxy. Tranſparency 1. 2. c.

Fracture large or ſmall, plane or curved, or undulatingly FOLIATED, more rarely ſtriated

Hardneſs from 4 to 8. Specific Gravity 3,4522 Brisson. 3,521 Gillert. Of the ſpecimen O. 3253 Leske, 3,048. Of a ſpecimen I had from Hungary, 3,435. yet Bergman makes it 5,315. which I ſuppoſe a miſtake The ſpecimen whoſe Hardneſs was 8. was greeniſh-yellow and abounded as I think in Quartz

Streak Orange-yellow, not Metallic.

With nitrous acid when heated it effervesces.

Burns with a bluiſh white flame.

Beto.e

Before the blow-pipe it melts, ſmokes, and vaniſhes leaving only a little earth behind and ſome traces of Iron. If gently heated ſo as not to melt, it reddens.

According to HAHNEMAN, water diſſolves at 212°. $\frac{1}{5000}$ of its weight of Orpiment.

In general it is thought to conſiſt of 90 parts of Arſenic, and 10 of Sulphur per cent. But WESTRUMB ſays it contains 80 per cent. of Sulphur, and 20 of Arſenic, which ſeems to me more probable. 1 WESTR. 99.

SECOND FAMILY.

REALGAR.

Rothes Rauſchgelb, of Werner.

Scarlet, Crimſon, or blood red, often mixed with yellow traces.

Found maſſive, diſſeminated, overlaying, or cryſtalized in middle ſized acute angled quadrangular or ſmall acicular priſms their lateral edges partly acuminated partly obtuſe and thence difficultly determined.

External luſtre 3. 2. Internal 2. 1,5. common. Tranſparency 3. 2. 1. 0.

Fracture, UNEVEN or paſſing into the minute CONCHOIDAL.

Its hardneſs 5. 6. Specific gravity 3,3384 BRISSON.

Streak

Streak yellowish red, not metallic, powder scarlet.

Nitrous acid soon robs it of its colour.

Before the blow-pipe it melts easily, burns with a blue flame and alliaceous smell and is soon dissipated. According to 1 Westr. 83. 100 parts of it contains 20 of Sulphur, and 80 of Arsenic.

CHAP.

CHAP. XII.

BISMUTH.

Its colour is white darkened by a ſhade of red, or yellowiſh red.

Luſtre 3. 4. Tranſparency 0. Broad foliated, or confuſedly broad ſtriated.

Hardneſs from 5 to 6 brittle. Specific gravity 9,8227 Brisson. 9,756 Gellert.

Next to Tin it is the moſt fuſible of metallic bodies; ſuddenly expoſed to a ſtrong heat it flames, and ſublimes in the form of a yellowiſh ſmoke forming flowers that afterwards vitrify into a browniſh glaſs. In cloſe veſſels it ſublimes unaltered.

Neither vitriolic nor marine acids attack it, but with the aſſiſtance of heat, and hold but little of it in ſolution, but the nitrous acid and Aqua Regia rapidly attack it. The ſolution however is in ſome meaſure precipitable by the mere affuſion of water.

The acetous acid does not take up calces of Biſmuth as it does thoſe of lead.

Its calces give a white or grey tinge to Borax. To Miſcrocoſmic ſalt a ſomewhat browniſh yellow, as it ſometimes does to Borax alſo. Per Engestrom.

SPECIES

SPECIES I.

Native Bismuth.

White, with a ſhade of red, but more commonly irideſcently tarniſhed red, yellow, or purple, particularly when found with Cobalt.

Seldom found maſſive, more commonly diſſeminated, overlaying, Reticular, or in Lamellæ, divergingly ſtreaked as from a ſtem like a feather, or Cellular, or corroded; more rarely cryſtalized in ſmall quadrangular tables, or indiſtinctly Cubic.

Luſtre 3. 2. Metallic. Tranſparency 0

Fracture, foliated, or broad striated or intermediate between the Foliated and the Striated.

Hardneſs 6. Specific gravity 9,022 Brisson. I found that of the ſpecimen O. 2932. to be 9,570. Exceeding fuſible.

Before the blow-pipe it gives a ſilvery white bead, but by a continued blaſt evaporates in a yellowiſh white ſmoke which depoſits on the Coal.

It is generally accompanied by Cobalt.

SPECIES

SPECIES II.

Mineralized by Oxygen, with or without Sulphur.

BISMUTH OCHRE.

1ſt. Of an Earthy consistence.

Its colour is yellowiſh, or greeniſh grey, or aſh grey, or ſtraw, or Sulphur yellow, or yellowiſh green.

Luſtre 0. 1. Tranſparency 0. Either duſty, or concreted to the conſiſtance of Chalk yet ſometimes from a mixture of Quartz, gives fire with ſteel, generally overlaying or inveſting other Ores of Biſmuth or Cobalt. Its Fracture UNEVEN or EARTHY. Heavy.

It is Soluble in Nitrous Acid without Efferveſcence, and in great meaſure precipitable by the affuſion of water.

Before the blow-pipe on Charcoal it may be reduced.

It has been often taken for the Green Martial Earth, Species 6th of the Iron Ores.

2d. Crystalized.

According to Baron Born * Its colour is greeniſh yellow, or grey.

And the form that of cubes or quadrangular lamellæ.

To diſtinguiſh whether the cryſtals or lamellæ be really a Calx of Biſmuth, they ſhould be diſ-

* 2 Raab. 219.

ſolved in Nitrous Acid, if they diſſolve without effervescence, or production of nitrous air, they are certainly of this ſpecies, otherwiſe native reguline Biſmuth, or of the following ſpecies.

SPECIES III.

MINERALIZED BY SULPHUR.

SULPHURATED BISMUTH.

Wiſmuth Glanz of Werner.

Tin white, or Steel or Lead grey, generally, Irideſcently tarniſhed, yellow, red, and purple.

Found Maſſive, or coarſely diſſeminated, ſeldom cryſtalized in ſcaly oblong priſms or acicular, or capillary.

Luſtre 2. 3. Metallic. Tranſparency 0.

Fracture, broad or narrow SRIATED, ſometimes FOLIATED reſembling Galena

Hardneſs 5. brittle. Specific Gravity 6,4672. BRISSON. But that of the Plumoſe priſms he lays at 4,571. That of the ſpecimen, O. 2940. I found to be 6,131. It generally ſtains, yet by BARON BORN the ſtriated does not.

Its ſtreak is obſcurely Metallic, its powder gliſtening and black.

According to SAGE it contains 60 per cent. of Biſmuth. Per LA PEYROUSE. 26 Roz. Jour. 438. it contains 36 per cent. of Sulphur.

Melts eaſily with a blue flame, and ſulphureous ſmell. 2 BERGMAN. p 500.

With Nitrous Acid it effervеſces when heated; the hot Marine Acid alſo has ſome action on it, and

and extricates hepatic air, it chiefly however affects the ſulphurated Iron which commonly accompanies this Ore. Galena effervesſces with Nitrous Acid hot or cold.

A variety of this Ore of a ſomewhat more ſilvery appearance found at DEUTSCH PILSEN in HUNGARY is reckoned by BARON BORN, and FERBER, a Silver Ore, and called MOLYBDENIC SIVLER ORE, and ſaid to afford 12 per cent. of Silver.* However KLAPROTH found it to contain nothing elſe than 95 per cent. of Biſmuth and 5 of Sulphur. The ſpecimen he examined was a piece of the ſame which BORN had deſcribed, which precludes all ſuſpicion of miſtake.

* 3 Nov. Act. Petropol. 267. 2. Raab. 419.

CHAP. XIII.

COBALT.

Its colour is white, inclining to the bluiſh or ſteel grey, or if tarniſhed, to red.

Luſtre, 3. Fracture compact, fine grained UNEVEN.

Hardneſs 8. and when very pure malleable in ſome degree in a red heat.*

Specific Gravity 7,8119. BRISSON. 7,645. GELLERT. 7,700. BERGMAN SCIAGR. But in his diſſertation on NICKEL he lays it 8,15. §. XIII.

When pure it is almoſt as difficultly fuſible as caſt Iron. Arſenic renders it more fuſible.

Magnetic even when pureſt. When freed from ſubjection to the Magnet, it is contaminated with Arſenic.

It is not volatil in cloſe veſſels.

It calcines the more difficultly as it is more pure, and in a ſtrong heat Its Calx is ſo deep a blue as to appear black; the mixture of Arſenic renders it brown, or reddiſh brown, it is exceeding difficult to fuſe. Whilſt in its Metallic ſtate it tinges no earthy ſubſtance, but in contact with fluxes it readily calcines.

Hence treated with Borax, Soda, Tartarin, or Microcoſmic Salt, in a ſtrong heat it tinges them BLUE.

* 7 Leonhard. 743.

In fusion it will not mix with Bismuth, Lead, or Silver, but by the mediation of Nickel it will unite to Bismuth. With Arsenic it burns with a bluish or white flame, according to the proportion of this latter.

With concentrated Vitriolic Acid it unites only in the heat of ebullition. The solution affords reddish crystals, but GREENISH if it be contaminated with much Nickel.

With the Nitrous Acid it unites easily and with effervescence. The solution is reddish or pale red, except Nickel predominates and then it is green, or if Arsenic, whitish at first, and soon after RED.

The Marine Acid acts on it difficultly and only with the assistance of heat; if the Cobalt be pure the solution is pale red, if contaminated with much Iron or Nickel, GREEN.

The Calces of Cobalt yield to Distilled Vinegar and also to Volalkali, and the solutions of the former are Red or Purple, of the latter blue when hot.

Aqua Regia also attacks it with Vigour; if the Cobalt be pure, the solution is red, if it abound in Iron, brown. This solution, or that in Nitrous Acid, if common Salt be added affords what is called sympathetic Ink, for tho' letters traced by it are invisible while cold, yet when heated they appear GREEN if the Cobalt retains much Iron, but BLUE if the Cobalt be free from Iron.*

Its solutions are not precipitable by Zinc.

Cobaltic Ores are known not only by the property of affording this sort of Ink, but principally by tinging Borax, or Sand, or Siliceous stones BLUE. For this purpose take one part of the roasted Ore, 3 of Pearl Ash, and 5 of Siliceous Sand. Mix them thoroughly, place them in

* Klaproth. 1 Berl. Beob. 184.

a luted

a luted crucible, heat them in a forge for 5 minutes gently, and for 25 minutes ſtrongly, with a loaded Bellows. Then dip the crucible in water to break it, and examine the colour of the Glaſs.

SPECIES I.

Cobalt alloyed with Arsenic, with or without Iron or Nickel

Dull Grey Cobalt Ore.

Grauer Speis Kobalt of Werner. Stahlderben Kobalt of others.

Its colour when freſh broken is whitiſh or bluiſh-grey, ſometimes more inclining to the one and ſometimes to the other, but after ſome time it becomes irideſcently tarniſhed, ſometimes bluiſh or greeniſh-black.

Found Maſſive, groſſly or minutely diſſeminated, ſcoriform,* or veiny, or reticular, very rarely ſpecular, or Botryoidal, or Nodular.

Luſtre o. 1. ſcarcely Metallic. Tranſparency o.

Fracture compact, generally EVEN, ſometimes UNEVEN, or paſſing into the FLAT CONCHOIDAL, the grain exceeding cloſe and minute. Fragments 3.

Hardneſs 10. difficultly frangible. That of the Black 8

Specific Gravity of the Specimen O. 3047, is 5,309 That of the ſpecimen O. 3062 is 5,511. That of the Black I found to be 4,360. Gel-

* Schlacken Kobalt of Lehman.

LERT

LERT mentions a ſcoriform Ore from RAPPOLD near SCHNEEBERG, whoſe Specific Gravity was 5,503.

Streak when it can be effected is bluiſh-grey and Metallic.

Smell when ſtruck, Arſenical, ſo alſo on burning Coals.

Both the Cobalt and the Arſenic are here in their Metallic State.

Before the blow-pipe it gives an Arſenical ſmell, but if it contains much Iron, it does not melt; Tho' with Borax which it colours dark blue, a ſmall Metallic bead is educed. See ENGESTROM in CRONSTEDT. 309.

If it contains but little Iron, it melts eaſily.

It is generally found with Native Biſmuth, Kupfernickel and Cobaltic efflореſcences.

The Corniſh Ore examined by KLAPROTH was of this Species,* it appears by his experiments to have contained about 20 per cent. of Cobalt, and 24 of Iron, and above 33 of Arſenic, the remainder being a few grains of Biſmuth a ſlight contamination of Sulphur, and loſs in reduction to a Regulus, with a trifling quantity of ſtony matter. Notwithſtanding this large proportion of Iron the Ore gave a good tinge.

The Ore of REICHELSDORF examined by MONCH,† ſeems alſo of this Species, he found no Sulphur or Iron in it; but with Arſenic it certainly contained Nickel, as it gave GREENISH cryſtals with the Vitriolic Acid, and hence he found it inſoluble or nearly ſo, in the Marine Acid. As this Acid difficultly maſters either

* 1 Berl. Beob. 182.

† 3 Crells Journal.

Nickel,

Nickel, Cobalt or Arſenic, hence eaſy ſolubility in Marine Acid is a proof of the exiſtence of Iron in Cobalt Ores.

The ſpecimen O. 3054. has externally a perfectly dull earthy appearance, is of a light reddiſh-grey, and in ſome places of a dark greeniſh colour, but internally it diſcovers ſteel grey bright ſpecular particles. Its ſurface is botryoidal, conſiſting of little roundiſh concretions with hollows between them.

This is a very rare appearance as KARSTEN remarks. How he found that it contains Native Biſmuth I cannot ſay, but by the experiments I made on it, it is plain it does contain it, and it is probable it is this incorporated with the Cobalt that gives the Ore the ſpecular appearance.

The Nitrous Acid acted upon it with effervefcence without the aſſiſtance of heat, and the ſolution was pale-green and ſoon after yellowiſh-green, but on diluting it, a white precipitate enſued, and the ſolution was greener. This ſhews it contained Biſmuth and Nickel. The Marine Acid did not act upon it until heated, and then it aſſumed a bluiſh-green colour, with a ſharp ſmell of Vitriolic Acid Air.

Hence it contains as I ſuppoſe both Sulphur and Iron. However KLAPROTH obtained a GRASS-GREEN ſolution from the Calx of this Ore in ſtrong Marine Acid, tho' there was no Nickel, and a BLUE from the Calx of the Regulus, but on adding water theſe colours diſappeared.

EVEN the Cobaltic Ores which from their Specific Gravity, one would deem the weakeſt, often give a ſtrong blue tinge to Siliceous Sand. Thus an Ore I had from CORNWALL, of the Species I now deſcribe, whoſe Specific Gravity was only 3,3[illegible]9 and contained much Arſenic, yet after roaſting, mixed with three parts Tartarin and five of

of Sand melted into an elegant glossy blue Glass.

SPECIES II.

Mineralized by Sulphur with or without Arsenic or Iron.

Bright White Cobalt Ore.

Kobalt Glanz, of Werner. Weisser speis Kobalt of others.

Its colour is Tin White, sometimes intermixed with darker particles, sometimes tarnished reddish or yellowish.

Occurs massive, disseminated,* overlaying, specular, reticular, nodular, corroded or crystallized in small or middle sized quadrangular prisms, or cubes, or double quadrangular pyramids, frequently with the solid angles truncated, &c. or resembling Garnets.

Lustre 2. 3. 4. partly Metallic, but partly 0. 1. Transparency, 0.

Fracture, generally fine grained UNEVEN, rarely fine STRIATED, or divergingly FIBROUS.

Hardness from 8. to 9 Specific Gravity of the Specimen, O. 3086. which is free from stony matter 6,284.

It is in general too hard to be scraped, its powder is steel grey.

When Arsenical it gives out that smell on burning coals, but does not melt The more sulphurated the Ore is, the more difficultly it melts. When free from Iron and not much sul-

* The disseminated may easily be mistaken for Mica.

phurated it melts easily. This is the Ore examined by the celebrated BRANDT in the Memoirs of UPSAL for 1742.* for it had much of the appearance of Mispickel, but when roasted it appeared black, and not reddish as Mispickel does; it contained no Arsenic † and afforded but little Sulphur, but a large proportion of Iron, yet gave a good tinge to Sand Another Ore of this Species was examined by RINMAN, and found to contain Sulphur, Arsenic and Iron. §. 151.

The Sulphurated Cobaltic Ore of HUNGARY contains by BARON BORN'S account neither Iron nor Arsenic. 2 RAAB. 124. It grows darker by exposure to the air, and its Crystals are of a dull white.

Another Ore of this sort free from Arsenic was lately discovered in SWEDEN by Mr. GEYER,‡ but SAGE found another Ore of this sort to contain above half its weight of Arsenic. 39 Roz. Jour. 55.

The Specimen, O. 3087. which is crystallized in small cubes, effervesced with Nitrous Acid, without the assistance of heat, and with Marine Acid when heated, it gave a greenish solution. Heated in a crucible it inflamed, but the flame was white, it contained some Sulphur and also Arsenic

Hence Iron enters into these Ores. Nickel seems less frequent, I have found none.

This Ore frequently affords 50 or 60 per cent. of Reguline Cobalt. RINMAN SCHW. ABH. 1780 160.

* 1 Mem. Swed. in French. p. 39.

† Rinman. §. 161. K.

‡ 1 Chym. Ann. 1788. p. 67.

SPECIES

SPECIES III.

Mineralized by Oxygen.

Of this I diſtinguiſh three Families, the black or bluiſh black, the brown, and the yellow.

FIRST FAMILY.

Black Cobalt Ore, Black Cobalt Ochre.

Scwartzer erd Kobalt, of Werner.

This is found in two ſtates.

1ſt. Loose. *Kobalt Mulm of Werner.*

Black, or bluiſh, or browniſh, or greyiſh black, and deſtitute of Luſtre.

It is of a looſe earthy conſiſtence, friable and meagre betwixt the fingers, which it ſullies.

Its ſtreak brighter. Soluble in Marine Acid.

Before the blow-pipe it ſeldom gives a white ſmoke or Arſenical or ſulphureous ſmell, but tinges Borax blue

2d. Indurated. *Schlacken Kobalt of ſome.*

Its colour is deep blue, or greyiſh or bluiſh black, or browniſh, or dark greeniſh black.

Found maſſive, diſſeminated, inveſting, corroded, botryoidal, kidney-form, or in veins.

Luſtre 0. 1 Tranſparency 0.

Fracture compact, EARTHY or EVEN, or paſſing into the FLAT CONCHOIDAL, or UNEVEN.

Hardneſs from 4 to 8. Specific Gravity variable from 3 to 4. ſometimes lower. GELLERT mentions one ſo low as 2,019. When ſoft it often gives a poliſhed ſtreak with the nail, the harder do ſo when ſtruck with Steel.

A Specimen of this ſort in my Cabinet from SCHNEEBERG, contains ſome bright Cobalt Ore internally.

Its colour is dark bluiſh grey inclining to black. Its ſurface ſcraggy and botryoidal

Its Fracture UNEVEN. Luſt e o. It gives a red ſolution with Nitrous Acid, and a bluiſh green with Marine Acid. It ſeems a decompoſition of the brighter Cobalt Ore

This Ore ſeldom contains any Sulphur or Arſenic, but often native Silver, or the vitreous Silver Ore intimately mixed with it; alſo Iron Ochre and diſintegrated Argillite.

According to 2 BERGMAN 447. green and blue clays ſometimes contain Cobalt, but the later oftener Copper

Before the blow-pipe it reſembles the former.

When its Fracture is CONCHOIDAL it has been called *Schlacken Cobalt*.

SECOND FAMILY.

BROWN.

Its colour is from the greyiſh to the dark leather brown, moſtly indurated, ſometimes friable.

The colour is probably from a mixture of Iron. 2 RAAB. 190. Its appearance is perfectly dull and earthy as is its Fracture, ſometimes ſlaty, and often

often remarkably light. It often betrays Arſenic when thrown on burning coals. Streak brighter, Unctuous. It communicates a pale blue tinge in fuſion.

THIRD FAMILY.

YELLOW.

Its colour is from the greyiſh yellow, or yellowiſh grey, to the Sulphur yellow, often ſtreaked with brick red. Its hardneſs from 4 to 5 Its appearance dull and earthy. Its Fracture, EARTHY or UNEVEN.

Its ſtreak, brighter Unctuous.

Often mixed with calcareous particles and Ochre of Iron

The blue tinge it affords is weak and ferruginous.

The Specimen, O. 3122. which conſiſts partly of the yellow and partly of the brown calx, and is very impure, after imbibing much water had its Specific Gravity 2,677. heated, it became reddiſh brown, and mixed with three parts Potaſh and five of Sand afforded a bluiſh green Glaſs, the green undoubtedly from Iron.

GREEN Cobalt Ores have alſo been mentioned, but theſe ſeem nothing more than Nickelo Ochre or Iron-ſhot mountain green.

SPECIES

SPECIES IV.

MINERALIZED BY THE ARSENICAL ACID.

RED COBALT ORE.

Of this Mr WERNER diſtinguiſhes two Families.

FIRST FAMILY.

COBALTIC GERMINATIONS, FLOWERS OF COBALT OF SOME.

Kobalt bluthe of Werner.

Their colour is peach bloſſom red, pale or deep, or crimſon or cochineal red.

Occur maſſive, diſſeminated, inveſting, or minutely botryoidal, or cryſtallized either in ſmall or minute right angled quadrangular tables, which are often divergingly accumulated, or in quadrangular acicular priſms, concentrically or ſtellularly arranged, or in ſmall ſomewhat broad ſix ſided pyramids, all often confuſedly implicated.

External Luſtre 2. 3. common. Tranſparency 0. 2. Hardneſs 5. 6. brittle.

The ſmallneſs and ſcanty quantity of the Specimens I poſſeſs prevented me from making any farther obſervations.

Before the blow-pipe they become blackiſh grey, diffuſing a weak Arſenical ſmell, but tinge Borax blue.

SECOND

SECOND FAMILY.

Cobaltic Incrustations.

Kobalt Beschlag of Werner.

These are also of a pale or clear peach blossom red.

Found either in a dusty or indurated form, the latter disseminated, or investing, seldom massive, or botryoidal.

Lustre 0. Transparency 0. Fracture, UNEVEN OR EARTHY. Hardness from 5 to 7.

The massive are often called COBALTIC SINTERS.

This Species is generally thought to be mineralized by the Arsenical acid, and with great reason, as Arsenic abounds in Ores from whose disintegration the red Ore originates. It is certain that Cobalt does not assume a red colour until it is highly oxygenated and united with an acid, for its Calces are naturally deep blue or black. Sulphur is also often found in Cobaltic Ores, and its acid may produce a red calx, but Vitriol of Cobalt if exposed to the air cannot be permanent, as it is soluble in about 24 times its weight of water, whereas Arsenicated Cobalt is nearly insoluble. The Arsenical part betrays itself by its smell when the Ore is projected on burning coals.

Some other Ores have lately been mentioned, but their existence does not appear to me sufficiently authenticated.

To these already mentioned we may add the green and violet Cobalt Ores found in HUNGARY, and mentioned by BARON BORN.

GREEN

GREEN COBALT ORE.

By BARON BORN's account it is found in the form of ſhining capillary apple green Cryſtals, ſtellularly diſpoſed, in prominent rounded groups. He judged it to contain Arſenic and Nickel. But BERGMAN expoſing it to the blow-pipe with Microcoſmic Salt, found it indeed to tinge it blue, but with ſtreaks of RED that betrayed Copper. Sometimes Nickel Ochre, or Iron-ſhot MOUNTAIN GREEN have been miſtaken for green Cobalt Ore.

VIOLET COBALT ORE.

This the Baron tells us is found in HUNGARY cryſtalized as the former.*

* 2 Raab. 188. and 189.

CHAP.

CHAP. XV.

NICKEL.

Nickel is a Metallic ſubſtance which is difficultly purified; when pureſt it is magnetic and hence has been deemed, though as I think without ſufficient reaſon, to contain Iron even when it exhibits no other ſign of its containing any.

When pure, its colour is greyiſh white, when leſs pure it diſcovers ſome ſhades of red or yellow, and ſoon darkens by expoſure to the air.

Luſtre, 3. Fracture, COMPACT or HACKLY, when leſs pure, FOLIATED.

Malleable to a conſiderable degree, though much leſs ſo than the intire metals, as they are called, when impure brittle, though difficultly frangible.

Hardneſs 8. Specific Gravity, even of the pureſt, is variable according to its more or leſs perfect fuſion, from 7 to 9. It is true BERGMAN found a Regulus, whoſe Specific Gravity was 9,3333, but it does not appear to me to have been as pure as ſome others of inferior denſity. The Specific Gravity of the impurer Reguli reaches from 7,421 to 8,500.

The Vitriolic Acid attacks it only in a boiling heat, and when diſtilled to dryneſs; tho' the Calces of this Semi-metal yield to it more eaſily.

The Nitrous Acid diſſolves it with the aſſiſtance of heat, and alſo its Calces.

The Marine Acid, attacks it alſo, but more ſlowly.

 The

The Acetous is impotent, with respect to it, but acts on, and cryſtalizes with its Calces.

All theſe ſolutions are green, and cryſtalizable, and precipitable greeniſh-white by fixed Alkalis. Volalkalis alſo precipitate them, but added to exceſs re-diſſolve the Calces, and the ſolution is BLUE, even Metallic Nickel yields to Volalkalis. 2 BERGM. 259. Its ſolution in Acids is not precipitable by Zinc, tho' it is in ſome meaſure by Iron.

Whether pure or impure, Nickel is Magnetic, ſometimes actively, always paſſively, unleſs the abundance of Arſenic mar that effect.

In a ſtrong heat Nickel calcines ſlowly, if pure, its Calx is brown,* if impure greeniſh, riſing in tuberoſe vegetations, proceeding from Iron or Arſenic. When pure it requires to melt it, as ſtrong a heat as caſt Iron, the impure melts more eaſily.

Its Calces communicate a HONEY-YELLOW colour to Microcoſmic Salt, a BROWN or REDDISH-BROWN to Borax and to Soda, but a BLUE to Tartarin, as KLAPROTH has diſcovered, which explains the reaſon of the Blue colour obſerved by BERGMAN in treating this ſubſtance with Nitre.

BERGMAN obſerved a ſolution of depurated Nickel in Aqua Regia to be precipitated by that of Vitriol of Iron, like that of Gold; but the precipitate is ſoluble in Nitrous Acid, which that of Gold is not.†

* 2 Bergm. 237. and 238.

† 2 Bergm. 253.

SPECIES

[redacted]

SPECIES I.

NATIVE NICKEL, ALLOYED WITH IRON.

When fresh broken its colour is pale-yellow, but exposed to the air it tarnishes into greyish-black. Occurs crystalized in Rhomboidal tables heaped on each other.

Fracture FOLIATED.

It contains, by BARON BORN's account, neither Cobalt nor Arsenic, nor Sulphur, as it seems it exhales no smell when calcined.

In other respects it should exhibit the properties of Nickel just mentioned.

It is found at JOACHINSTAL in BOHEMIA, 2 RAAB. 209.

SPECIES II.

MINERALIZED, PARTLY BY OXYGEN, AND ARSENICAL ACID, AND PARTLY BY VITRIOLIC ACID. NICKEL OCHRE, AND VITRIOL OF NICKEL.

Nickel Ochre of Werner.

These substances are commonly found mixed with each other, and in general present two distinct appearances, the Loose and the Indurated.

LOOSE.

Pale apple-green, ſeldom bluiſh-green, or graſs-green, oftener greeniſh-grey, or greeniſh-white, when wetted their colour is exalted.

Generally found efloreſcing on the ſurface of other Nickel Ores, in a dull earthy or duſty form, and thereby characteriſing them; or diſſeminated, ſeldom in ſolitary maſſes, and commonly mixed with ferruginous Ochre. Give an earthy ſmell when breathed on. And ſlightly ſtain the fingers, often mixed with Clay, Magneſia, and mild Calx.

The Vitriol of Nickel, when mixed with this Calx, is eaſily ſeparated from the mere Calx by ſolution in water; the ſolution duly evaporated, affords oblong Rhomboidal Cryſtals, precipitable by Alkalis into a greyiſh-green Calx, ſoluble in Acids, which it tinges GREEN; or in Volatile alkalis, whoſe ſolution is BLUE. Before the blow-pipe Nickel Ochre does not melt, but gives a yellowiſh and almoſt reddiſh-brown tinge to Borax.

INDURATED.

Light or dark Canary-green.

Found Maſſive or acicularly cryſtalized, ſometimes ſtriated like Actinolite.

Luſtre 1. 0. Fracture Earthy. Specific Gravity conſiderable.

Slowly ſoluble in Acids, with a green colour.

It exiſts in the BOGOJAVLENSKY mountains in SIBERIA, where it contains much Silver. RENOVANTS. 235.

The

The Calx of Nickel frequently enters into the composition of greenish stones, and particularly of Crysopratium in which it is found in its purest state.

SPECIES III.

MINERALIZED BY THE ARSENICAL ACID.

ARSENICATED NICKEL.

This Ore was lately discovered at REGENSDORF by Mr. GMELIN. He describes it as follows:*

Its colour is pale-grey, here and there mixed with pale-green, when moistened its colour is more lively.

Found in shapeless masses, often mixed with Lamellar Baroselenite.

Lustre 0. Transparency 0.

Fracture Compact, partly EARTHY, partly SPLINTERY.

Hardness 7. difficultly frangible. Specific Gravity considerable.

Adheres slightly to the tongue, and gives an earthy smell when breathed on. Gives a white streak.

Soluble in the Nitrous and Marine Acids, in a strong heat, and the solutions are GREEN, but deposits no Copper when essayed by Iron. The solutions are precipitable, by and re-dissoluble BLUE by Volalkali, mild or caustic.

Mr. GMELIN examined this Ore with the most scrupulous exactness, and with an attention to the agreeing or disagreeing experiments of preceding writers, that renders the essays of this cele-

* 1 Chy. Ann. 1794. 1.

brated

brated Chymift peculiarly interefting and inftructive. He found it, befides the Arfenical Acid to contain fome traces of Cobalt and a fmall proportion of Argill, and in fome inftances of Barofelenite.

SPECIES IV.

MINERALIZED BY SULPHUR AND ARSENIC, WITH IRON, AND OFTEN WITH COBALT.

SULPHURATED NICKEL.

Kupfer Nickel of Werner.

Of a light or deep Copper-colour, feldom yellowifh-white, or grey, and ftill more rarely of a lead-grey. Its recent fracture, often Silvery-white.

Found maffive or diffeminated, rarely Reticular, frequently covered with Nickel Ochre.

Luftre 2. 1. Metallic.

Fracture Compact, fine grained UNEVEN, verging to the CONCHOIDAL, or minute FOLIATED, or STRIATED, often prefents curved Lamellar concentric diftinct concretions.

Hardnefs 8. Specific Gravity from 6,60·6. to 6,64·1. BRISSON.

Soluble in Nitrous Acid and Aqua Regia, to which it gives a green colour as the Regulus, already mentioned.

Before the blow-pipe it exhales an Arfenical fmell and fmoke, then melts into a bead, which darkens by expofure to the Air.

Heated in a crucible it lofes from [illegible]5 to 55 per cent. of its weight by the diffipation of Sulphur and

and Arſenic, and then calcines as the Regulus. It affords Regulus of Nickel in the proportion of from 10 to 50 per cent.

It often contains alſo Biſmuth, and ſometimes Silver and Copper, and moſt frequently accompanies the grey or white Cobalt Ores. It effloreſces by long expoſure to the air, and its eſfloreſcence is greeniſh.

Of the Lead-coloured Ore I find no mention but in RENOVANZ. Its colour he tells us is intermediate between that of the grey Copper Ore and the grey Silver Ore, but ſurrounded with green particles, and with blue Calx of Copper. Luſtre 1. difficultly frangible but brittle. Hardneſs from 7 to 8. weight conſiderable.

It affords, together with SPEIS (which is a compound of Nickel and Cobalt) alſo Copper and Silver.

Soluble in Nitrous Acid, and the ſolution is GREEN. Volalkali ſeparates from this ſolution, firſt a yellowiſh (the Cobalt) and then a greeniſh precipitate.

RINMAN obſerved that if a ſolution of Cobalt and of Zinc be mixed together, and afterwards precipitated by an Alkali, the precipitate will be RED, but after calcination more or leſs GREEN, according to the proportion and purity of the ingredients. But if this roaſted Calx be re-diſſolved, the ſolution will be red; and in reduction in the uſual way, the Zinc diſappears, and the Cobalt alone remains. 2 BERGM. French tranſlation in a note from a letter of BERGMAN's, p. 270.

Cobaltic Ores generally accompany it.

CHAP

CHAP. XVI.

MANGANESE.

Its colour is greyiſh white, but ſoon darkens by expoſure to the air.

Luſtre 3. 2. Fracture UNEVEN, in no degree Malleable.

Hardneſs 8. difficultly frangible. Specific Gravity 6,850. per 2 BERGM. or 7,000. as HIELM has lately found it.

When pulveriſed it is magnetic, rarely ſo when in lumps.

In general it quickly calcines by expoſure to air, particularly moiſt air, and then is at firſt greyiſh white, but gradually darkens, until at laſt it becomes black, friable betwixt the fingers, however it ſeems it does not always thus pulverize, for KLAPROTH found a Regulus extracted from the Manganeſe of ILFELD to perſiſt in its integrity for two years, though expoſed to the viciſſitudes of the Atmoſphere.*

The concentrated VITRIOLIC ACID attacks it, but the dilute more powerfully, leaving a ſpungy maſs undiſſolved. Is not this, Carbon abſorbed during its fuſion? The ſolution is colourleſs and affords white bitter Cryſtals. It yields alſo to the NITROUS ACID, and the ſolution is ſomewhat brown, by reaſon of ſome ferruginous particles undiſſolved.

* 1 Chym. Ann. 1789. 11. Does not this proceed from its containing leſs Carbon, which Manganeſe like Iron abſorbs when in fuſion, and which afterwards abſorbs moiſture, and Oxygen, ſwells and burſts? Bergman has found it in Regulus Manganeſe. 3 Bergm. 379.

The

The MARINE ACID alſo unites to it, and the ſolution is colourleſs; the ACETOUS though apparently inactive at laſt by particular management maſters it.

Heated, it is ſoon converted into a BLACK CALX and if in a common crucible and ſtrongly urged runs into a yellowiſh brown glaſs, depoſiting Reguline Iron.

The black Calx thus obtained, or by oxygenation by expoſure to the Atmoſphere, is ſcarcely ſoluble and only in ſmall quantity, in common vitriolic acid, and the ſolution is RED, but eaſily in the ſulphurous, and the ſolution is colourleſs.

It unites ſtill more difficultly to the NITROUS, except by particular management or the addition of Sugar, &c. and then the ſolution is colourleſs.

The MARINE unites to it more eaſily but the ſolution is reddiſh.

The ACETOUS alſo takes up the black Calx though ſlowly and very ſparingly.

If from any of the ſolutions above-mentioned the Manganeſe be ſeparated by an aerated fixed Alkali, the precipitate will be WHITE. This white Calx is but ſlightly oxygenated, in compariſon of the black is eaſily ſoluble in all the above acids, and the ſolutions are colourleſs. But if this Calx be heated or long expoſed to the air it will blacken and acquire the properties of the black Calx.

The black Calx being fully oxygenated communicates various tinges to ſubſtances with which it is fuſed.

Thus if aſſociated with Microcoſmic Salt or Borax on Charcoal and urged by the blow pipe, it will beſtow on them a RED tinge, which the

internal BLUE flame, being loaded with unſaturated inflammable air and carbon, will ſoon deſtroy, but the external flame or Nitre will again reſtore.

VEGETABLE ALKALI aſſumes from it a BLUE or violet colour, or, if the Manganeſe be loaded with Iron, a GREEN, (the addition of white Arſenic to the melted maſs will deſtroy the colours).

This blue tinge has ſometimes occaſioned it to be miſtaken for Cobalt, but if the blue maſs be diſſolved in common water, the miſtake will ſoon be diſcovered as the ſolution will firſt become GREEN, then BLUE and finally RED, (the addition of an acid in ſmall quantity will accelerate this effect) the precipitate will ſoon blacken. To Soda it gives a RED tinge.

Of all metallic ſubſtances that of Manganeſe, is after Iron, the moſt generally though minutely diffuſed through the earth.

SPECIES I.

NATIVE MANGANESE?

Greyiſh white. Found in ſomewhat flatted lumps.

Luſtre, 3. metallic. Fracture divergingly broad FOLIATED, in ſome degree malleable.

Hence it ſhould have ſome conſiſtence yet it is alſo ſaid to ſtain the fingers, conſequently muſt be diſintegrated by Oxygenation. Not magnetic. Said to have been diſcovered in the Valley of VIEDERSOS in the County of FOIX, by Mr. DE LA PEYROUSE 1 MEM. TOULOUSE 256. 28 Roz. Jour.

Jour. 68.* if it exifts it is probably the abfence of CARBON that faves it from the difintegrating power of the Atmofphere.

SPECIES II.

MINERALIZED BY OXYGEN.

Of this there are two Families, the grey and the black.

FIRST FAMILY.

STRIATED OR FIBROUS.

GREY ORE OF MANGANESE.

Grau Braunftein erz of Werner.

Commonly dufky fteel grey, yet fometimes light whitifh grey, or reddifh grey.

Occurs maffive, differminated, in nefts or rifts, or ftalactitic, or cryftalized in flender oblong acute angled quadrangular prifms or needles, or in very minute right angled quadrangular, or fafcicularly accumulated tables.

External luftre 3. 2 Internal 2. 1. Metallic. Tranfparency, 0.

Fracture, moft commonly broad or narrow, long or fhort, ftellularly or fafcicularly or tranfverfly STRIATED, more rarely FOLIATED. Fragments fometimes long SPLINTERY.

* Yet I fufpect fome miftake to have happened, for Mr. Chaptal who refides in the South of France and whofe Elements of Chymiftry appeared fome years after this fuppofed difcovery exprefsly fays " Le Manganefe paroit etre toujours a l'etat D'Oxide." 2 Chaptal. 254.

Hardneſs from 4. to 5. brittle. Specific Gravity of the ſtriated from 4,2 9 to 4,7563. Brisson, or 4,181. Rinman,* and of the foliated or tabular, which he calls Scaly 4,8165. Brisson.

Ferber mentions a radiated Ore ſo light as to float on water.

Streak and powder, black and opake.

Does not efferveſce with acids, and is ſcarcely affected by the nitrous, without the addition of Sugar, with the Marine when heated, it developes the ſmell of the Oxymuriated Acid.

Heated in a crucible it neither ſmells nor ſmokes but grows rather darker, and does not become Magnetic.

Before the blow-pipe it darkens, and gives to Borax a reddiſh brown ſomewhat violet tinge.

This Family is generally the freeſt from Iron, yet it contains ſome proportion of ferruginous Sand, and often Barolite and Siderite. That of Islefeld is of this Family and in it Bindheim found a ſmall proportion of Calcareous and Barytic earths, an Atom of Copper, and no Iron. 2 Chym. Ann. 1789. 31.

SECOND FAMILY.

Black or Brown.

Pure or bluiſh black, or browniſh black, or reddiſh brown, or browniſh red from a conſiderable mixture of Iron Ochre.

Found either in an earthy pulverulent or indurated ſtate.

* Schwd. Abhand. 1765. 252.

Earthy

Earthy, Ochre of Manganese.

Sometimes ſcaly with ſome luſtre tho' moſtly dull and ſtaining the fingers * ſometimes in acicular fragments †. Though this ſeems rather the former Family comminuted.

Sometimes dull powdery or in ſmall lumps, friable betwixt the fingers, often feels ſmooth, but often harſh and meagre as that called BLACK WAD which is generally rather blackiſh or reddiſh brown, and is well known for its property of affording a ſpontaneous inflammation when mixed dry with one fourth its weight of Linſeed Oil and gently heated. It melts into a ſlag at 95°. of Wedgewood, and at 144°. into a perfect glaſs. Acids in ſufficient quantity diſſolve about $\frac{11}{12}$ of it with the aſſiſtance of heat.

Mr. WEDGEWOOD found this WAD to contain 43 per cent. of Manganeſe, 43 of Calx of Iron, 45, of Lead, and 5 of Mica.

Mr. BERGMAN found another ſpecimen to contain 12,5 per cent. of Silex, ſome Lead Ore Calx of Iron and Barolite, the remainder Calx of Manganeſe. The Nitrous Acid without the addition of Sugar took up only the Calx of Lead and Barolite, but after that addition both the Calx of Manganeſe and that of Iron, and thence aſſumed a yellowiſh brown colour. 2 Chym. Ann. 1785. 398.

All theſe are affected before the blow pipe as the former Family.

* 1 Rinman Ibid.

† 2 Chaptal.

INDURATED.

INDURATED.

This is found either maſſive or diſſeminated, incruſting, cellular, porous, cavernous, often with rounded impreſſions, ſtalactitic, botryoidal, kidney-form, pectinated, &c.

External Luſtre, being coated with Iron, or the above Ochre 0. 1. Internal Luſtre 0. 1. Metallic. Tranſparency 0.

Fracture Compact, EVEN, FLAT CONCHOIDAL or fine grained UNEVEN, ſometimes imperfect curved FOLIATED.

Hardneſs from 5 to 7. Specific Gravity of the porous before it has abſorbed water 3,7076. after abſorption 3,9039 BRISSON.

The uncryſtalized commonly preſents curved Lamellar diſtinct concretions turned outwards

Streak, of the harder ſorts black, Metallic, of the ſofter, black Opake.

Sometimes it acquires alſo a poliſh from the nail, like the black Cobaltic Ore, being mixed with Clay.

Before the blow-pipe it reſembles the former family. EXTERNALLY it hath ſome reſemblance to BROWN HÆMATITES

It differs from the former family in Colour, Hardneſs, Specific Gravity and Luſtre.

WESTRUMB found in the black Calx of RENGERSDORF which had been miſtaken for Cobalt, 45 per cent. of Manganeſe, 14 Calx of Iron, 11 of Silex, 7,25 of Argill, 1,5 Calx of Copper, 2 Calcareous Earth and 18 of Air and Water,* And from the ſame Ore he obtained 2 per cent.

* 2 Weſtrumb, 2 heft. 199.

of

of fixed Air, 5 of pure Air and 6 of Water by Diſtillation. 2. WESTRUMB. 1. heft. 134. (the Ore then became Red. Hence the Red Ores certainly contain leſs Oxygen than the black) which agrees well with the experiments of ILSEMAN who found it to loſe by calcination about 12 per cent. of its weight. 4. N. ENTDECK. 27.

GADOLIN in another Ore of this Species from UNDONAS IN WEST GOTHLAND, found 18 per cent. of Sand beſides a mixture of Barſolenite, and Siderite. 1 Chy. Ann. 1790. 139. But I believe this was of the firſt Family. See Schwed. Abhand. 1785. 142.

Many ſtones participate ſtrongly of this ſubſtance, ſome of which deſerve Notice.

1ſt. PERIGORD STONE. Its colour is browniſh-black.

Luſtre 1. Fracture Compact. Hardneſs 6. Specific Gravity conſiderable.

Heated it hardens and becomes reddiſh-brown, but not Magnetic, gives a Red or violet tinge to Borax; and is affected by Nitrous Acid as the Black Calx of Manganeſe. It contains beſides Manganeſe both Clay and Iron.*

2d. Moſt Stones of a VIOLET-COLOUR derive that colour from this Ore, a few only from Iron or Gold.

If the Black, Brown or Red Calces of Manganeſe be digeſted with Cauſtic Volalkali, they become grey or white. per FOURCROY Mem. PARIS. 1788. 378. This however I did not find to happen in digeſting nor even diſtilling Cauſtic Volalkali over the black cryſtalized Ore, nor the Reddiſh-black Calx.

* Wallerius and Rinman Schwed. Abhand 1765.

According

According to the Analysis of the Stone which STUCKE calls VESUVIAN it should seem that this should be its proper place; for he attributes to it 40,12 per cent. of Manganese contaminated with Iron, 16,25 Iron, 16 mild Calx and 26,5 Silex.

Its colour he says is reddish and yellowish-brown or Resin-brown. Its Lustre 2. 3. glassy. Transparency 2. 3. Fracture CONCHIODAL. Hardness 10. Specific Gravity from 3,6 to 4,c00.

It is infusible in a violent heat, and remains in all respects unaltered by it; but on Charcoal it vitrifies before the blow-pipe, and even in a clay crucible in a porcelain heat † KLAPROTH.

Melted with 3 times its weight of Soda it gives a CANARY GREEN slag, and with 4 times its weight of Tartarin, a whitish GREEN glass. These colours indicate a predominance of Iron. In this Analysis imperfect as it may appear, STUCKE displayed admirable candour and patience with no small degree of ingenuity and chymical knowledge.

SPECIES III.

MINERALIZED BY OXYGEN AND FIXED AIR.

Of this there are two Families, the White and the Red.

FIRST

FIRST FAMILY.

White Calx of Manganese.

Clear White, or ſomewhat Reddiſh White.

Found either looſe, or maſſive, diſſeminated. or in rounded protuberances, or acicularly cryſtalized.

Luſtre of the ſcaly 2. common. Tranſparency 1. in very thin pieces, 2.

Fracture curved FOLIATED.

Hardneſs of the maſſive in the ſpecimens I tried from 6 to 7. rarely 9. Specific Gravity of the ſpecimen O. 3210 is 2,794. Effervefces with Mineral Acids, and with the Marine gives the ſmell of Aqua Regia, which is remarkable.

Heated to Redneſs, it blackens and then ſcarcely effervefces with Nitrous Acid.

I found the ſpecimen in LESKE's Collection above-mentioned to exhibit theſe Phænomena and to contain 37 per cent of Air. Of which the greater part was fixed Air.

It is in this ſtate that Manganeſe moſt probably exiſts in Siderocalcite and the Sparry Iron Ore.

Before the blow-pipe it gives a violet colour to Borax.

The ſcaly Ore has often been confounded with the brown ſcaly Iron Ore.

SECOND FAMILY.

Red Ore of Manganese.

Pale Roſy Red, with a ſtrong mixture of white; when reduced to powder, nearly white.

Occurs either in a loose Earthy form, or massive, disseminated, stalactitic, botryoidal, or crystalized lenticularly, or in Rhomboids, or minute pyramids, or acicularly.

Lustre 0. Transparency scarcely 1.

Fracture fine grained UNEVEN, or minute splintery, perhaps obscurely FOLIATED, or tending to the flat CONCHOIDAL but so finely as to be difficultly perceptible, the massive is also in the gross flaty.

Hardness 8. Specific Gravity of a fragment of the specimen O. 3203, which was free from all perceptible mixture of heterogeneous particles 3,233.

This same specimen I found to become reddish-brown by being heated to Redness.

It effervesced slightly with the Nitrous and Marine Acids.

This is the fossil that has been taken by BARON BORN and others for a Felspar and was called FELSPAR of KAPNICK. but Mr. RUPRECHT found it to consist of 55 per cent. of Silex, 35 of Calx of Manganese, 7 of Calx of Iron, 1,5 of Argill, with a small proportion of Water. With Borax it effervesced and gave it a Red tinge.* It is the Matrix of Gold at NAGAYA.

As this Ore effervesces with Acids and by the above Analysis contains no substance that can do so but the Calx of Manganese, I am persuaded that it is the white Calx that is contained in it, and its change of colour when heated confirms this supposition. The red colour must then proceed from the Calx of Iron dispersed through this fossil. The only essential parts of this Ore are the Calx of Manganese and the red Calx of Iron, the

* 31 Roz. Jour. 22. 1 Born Phys. Arbeit. 55.

other

other ingredients it ſeems are fortuitous as appears in the following varieties.

1ſt. THE CHERRY RED ORE OF SAVOY, appears by the experiments of CHEVALIER NAPION, to conſiſt of 26 per cent. of Silex, 45 of a mixture of Calx of Manganeſe and Calx of Iron, the remainder mild calcareous earth. 10. Ann. Chym. 148.

Its colour is deep cherry red, even when reduced to powder. It is found maſſive Tranſparency O. Hardneſs 8. brittle; fracture, EVEN preſenting ſtreight columnar concretions. Calcined it blackens. By the blow-pipe it is converted into a red Scoria, ſo deep as to appear nearly black. Melted in charcoal with borax it gives a clear glaſs, which nitre renders purple. Mem. TURIN. 1788. 303. It is inſoluble in Vitriolic or pure Nitrous Acid, but yields to Marine Acid, eſpecially if Sugar be added.

2d. THE SPARRY ORE OF KLAPPERCUD IN SWEDEN, of which RINMAN gives ſome account in the Memoirs of STOCKHOLM for 1774, and which he ſays has ſome reſemblance to brown Blende.

Its colour is reddiſh brown, and reſembles that of Roſin.

Found maſſive or in irregular imperfect cubes.

External luſtre 3. 2. Tranſparency in thin pieces 2.

Fracture, Foliated.

Hardneſs from 6. to 7.

Digeſted in common Aqua Fortis it diſſolves for the greater part, without effervescence or change of colour. Fixed alkalies precipitate from this ſolution a white powder which blackens when heated and tinges Borax in fuſion red.

Calcined it blackens. Treated with Borax before the blow-pipe it effervefces and paffes into a dard red glafs.

According to BERGMAN it is a Semi Oxygenated Calx of Manganefe thickly diffeminated through Zeolyte.*

MINERALIZED BY THE VITRIOLIC ACID.

VITRIOL OF MANGANESE.

This has been lately found in the form of WHITE cryftals at MONTMARTRE near PARIS, 1 Chym. Ann: 1793. 167. Thefe cryftals are bitter to the tafte, eafily foluble in water, and efflorefce by expofure to the air.

* 2 Bergm. 215.

CHAP. XVII.

URANITE.

This semi-metal was lately discovered by KLAPROTH, who found it to possess the following properties.*

Its colour is dark steel or iron grey. Internally somewhat browner.

Lustre 2. Metallic. Hardness 6. to 7. Specific Gravity 6,440.

It has as yet been produced only in small globules imperfectly agglutinated.

It is rather more difficultly fusible than Manganese.

It is soluble in the Nitrous Acid. It does not appear that other Acids have been tried.

Before the blow-pipe it is infusible, but the addition of Microcosmic Salt, or concrete Phosphoric Acid converts it into a GRASS GREEN GLASS, and Soda or Borax only into a grey opake scoriaceous bead.†

Its CALX IS YELLOW, and manifests the following properties.

It is easily soluble in Acids. With the Dilute VITRIOLIC ACID, it affords yellow crystals.

With the concentrated ACETOUS, it affords yellow quadrangular crystals.

With the PHOSPHORIC, an Amorphous white difficultly soluble mass.

* 2 Chym. Ann. 1789. 387. &c.

† 2 Chym. Ann. 1789. 395.

It

It is alſo ſoluble in the NITROUS ACID AND AQUA REGIA. The ſolution in each is wine yellow, and affords greeniſh yellow cryſtals.

From the laſt mentioned ſolutions, the following precipitates were obtained.

BY SULPHURATED VOLALKALI, a browniſh yellow precipitate.

BY TINCTURE OF GALLS, (when the ſuperfluous Acid was ſaturated by an Alkali) a chocolate brown precipitate.

By PRUSSIAN ALKALI, a browniſh red precipitate, which is GRANULAR and diffuſed through the whole liquor, whereas the precipitate of Copper by this Alkali, which is of the ſame colour nearly, is FLAKY. That of Molybdena alſo reſembles it, but is not ſo brown.

BY AERATED FIXED ALKALIS of either kind, whitiſh yellow, much of which is rediſſolved by the fixed air ſet looſe.

BY CAUSTIC VOLALKALIS, lemon yellow.

By VOLALKALI, dark yellow.

Theſe ſolutions are precipitable neither by Iron nor by Zinc.

Uranitic CALX is inſoluble in Alkalis either in the moiſt or dry way, which fully diſtinguiſhes it from Tungſtenic Calx, which it otherwiſe reſembles in colour.

SPECIES I.

MINERALIZED BY OXYGEN.

Of this there are two Families, the Earthy and the Micaceous.

FIRST

FIRST FAMILY.

Uranitic Ochre.*

Commonly Lemon, ſometimes Sulphur, or Ochre yellow, the former tints often paſs thro' the Orange, into the light Red, the latter into the Canary Green.

It occurs maſſive, diſſeminated, or incruſting, ſeldom in veins.

Luſtre 0. Tranſparency 0.

Fracture, EARTHY, partly coarſe partly fine grained

Hardneſs from 3 to 4. Specific Gravity not determined

Streak, of the yellow ſorts, yellow; of the Red, Orange yellow.

Slightly ſtains the fingers, and feels meagre.

It is infuſible by the blow-pipe, by a ſtrong heat it becomes browniſh-grey.

Hitherto it has been met with only at JOHAN GEORGENSTADT in SAXONY.

It is generally fouled with Calx of Iron, the Clear yellow is the pureſt, and poſſeſſes the properties of the yellow Calx already mentioned.†

NOTE Mr. KARSTEN deſcried an INDIGO BLUE Metallic Subſtance repoſing on or mixed with Uranitic Ochre, which ſeems to have ſome

* This and the following deſcriptions are chiefly from Karſten. 4 Berl. Beob. 176.

† 2 Chy. Ann. 1789. 400

affinity

affinity to it, but whofe nature is as yet unknown, of which he gives the following defcription.

Colour Indigo-blue. Found diffeminated thro' or overlaying Uranitic Ores.

Luftre partly 0. partly 1. Metallic, Fracture EARTHY, does not ftain the fingers.

Its ftreak brighter and Metallic, and much refembles Purple Copper Ore.

SECOND FAMILY.

Micaceous Uranitic Ore.

Verharteter Urankalk of Werner.

Uran Spath of Others.

Its colour commonly EMERALD or GRASS GREEN, often ftrongly inclining to the SILVERY WHITE, more rarely to the CANARY GREEN, and intermediate between the SULPHUR AND WAX YELLOW.

Seldom found incrufting, more commonly in fmall or minute cryftals, as quadrangular tables or cubes, or 6 fided prifms, their furface commonly longitudinally ftreaked, feldom frofted with minute cryftals.

External Luftre 3. 2. Internal 2. fometimes Pearly, fometimes approaching to the Metallic.

Tranfparency 2. 3. Fracture, FOLIATED not fiffile.

Hardnefs from 5 to 6. fomewhat brittle. Streak, greenifh-white.

It

It is said to have hitherto occured only in the Pit of GEORGE WAGSFORT at JOHAN GEORGENSTADT in SAXONY. Yet Mr. NOSE seems also to have discovered it in the Countries adjacent to the RHINE.

This substance was at first denominated green Mica by Mr. WERNER for want of a more suitable name, for he knew it to differ from common Mica. Then as BERGMAN afterwards found it to contain Copper (the smallness of the quantity he possessed preventing him from discovering any thing else) WERNER called it CALCHOLITE. But KLAPROTH lately found it to consist of indurated or crystalized Calx of Uranite slightly tinged with Calx of Copper.

It is slowly soluble in cold and without effervescence in Nitrous Acid; polished Iron is coated with Copper in this solution. Volalkali precipitates the copper Blue, and being added to excess re-dissolves it, and thus allows it to be separated from the Uranitic Calx. The yellow sort contains no Copper.*

It is insoluble in, and infusible by Alkalis.

SPECIES II.

MINERALIZED BY SULPHUR, SULPHURATED URANITE, URANERZ OF KARSTEN, FORMERLY PECHBLENDE OF THE SAXONS.

Commonly brownish BLACK, sometimes greyish and bluish BLACK, or iridescently TARNISHED.

* 2 Chym. Ann. 1789. 402.

Found Massive, or imbedded, sometimes elliptically cellular or kidney-form.

Lustre 3. 2. 1. Semi-Metallic, rarely 0 and only when beginning to wither. Transparency 0.

Fracture flat or imperfectly CONCHOIDAL, or passing into the coarse grained UNEVEN, Fragments 3.

Hardness from 7 to 8. very brittle. Specific Gravity at a mean 7,500. KLAPROTH.

Streak somewhat darker; powder, Opake and Black.

It has as yet been noticed only at JOHAN GEORGENSTADT in SAXONY, and at JOACHIMSTHAL in BOHEMIA. In the former it is accompanied by the Oxygenated Ore already mentioned and described. In the latter by Barsolenite and the grey Cobaltic Ore.

KLAPROTH discovered this Ore to consist chiefly of Uranitic Calx and a small proportion of Sulphur, mixed with ferruginous stony matter, and casually with Lead Ore.

It is soluble in Acids, imperfectly indeed in the Vitriolic and Marine Acids, but perfectly in the Nitrous and Aqua Regia. The solution is of a dilute wine yellow, and holds the yellow Calx already mentioned.

This Ore is infusible PER SE by the blowpipe, with Soda and Borax it gives only a grey opake slag. But with Microcosmic Salt a green Glass.

By a slight calcination it loses part of its weight, but recovers part of it if the calcination be continued.

Treated with fixed Alkalis in a crucible it does not afford Liver of Sulphur, and is infusible by them.

The

The Alkali takes up ſome Siliceous particles only. Formerly this Ore was called Pechblende in SAXONY and ranged among the Iron Ores, as we ſee in LESKE O. 2676. 2677 and 2678. but by CRONSTEDT this name was given only to a Zinc Ore. The Ore of which we here treat, he was not acquainted with.

CHAP. XVIII.

TUNGSTENITE.

Scheelium of Werner.

This ſubſtance is capable of exiſting in three ſtates. That of a Regulus, which I call Tungſtenite. That of a Calx, and that commonly called the Acid of Tungſten.

In its Reguline ſtate it has the following properties.

Its colour is externally brown, internally ſteel grey.

Luſtre, 2. Metallic.

Hitherto it has been produced only in very minute Globules, being more difficultly reducible to a Metallic State than Manganeſe or Uranite.

Brittle. Specific Gravity 17,600. according to Meſſrs. ELHUYART, but of this I much doubt.

Inſoluble in the Mineral Acids, but convertible by the Nitrous and Aqua Regia into a YELLOW Calx. Theſe Acids alſo extract Iron from it.

By heat it is alſo convertible into a yellow Calx, and then increaſes 24 per cent. in weight.

In the ſtate of YELLOW CALX it has the following properties.

Its Specific Gravity is 6,12.

It is perfectly inſipid and inſoluble in water; if triturated with water it ſimply diffuſes through it like an Emulſion, and takes ſome months to depoſit from it. If Volalkali be poured on it, it whitens, which inſtantly diſtinguiſhes it from the yellow Calx of Uranite.

Expoſed

Exposed to the EXTERNAL flame of the blowpipe it continues yellow, though placed on Charcoal, but by the INTERNAL, it swells and blackens, but does not melt.* This BLACK colour however seems to me to be only a VERY DEEP BLUE.

If Microcosmic Salt be added it looses ALL COLOUR in the external flame but in the internal it gives a BLUE glass. But the addition of an Alkali, again renders this blue glass colourless.

With Borax it gives a BROWNISH YELLOW GLASS.

Heated PER SE on a burning coal, or in a crucible it becomes of a slate BLUE colour, 4 Berl. Beob. 321.

This Calx is insoluble in Acids, nor does it even diffuse through them. In the acetous howver, it assumes a blue colour, but does not dissolve.

But in Caustic Alkalis this Calx is compleatly soluble both in the dry and the moist way, and the solution always retains an excess of Alkali.

If to the solution in Caustic Tartarin a few drops of Nitrous Acid be added a WHITE precipitate will immediately appear, and a farther addition of the Acid will increase the precipitation, while an excess of Alkali remains, and the Liquor becomes bitter. This white precipitate is soluble by agitating the Liquor and has the properties of an Acid. But if so much Acid is added as to destroy the excess of Alkali, the white precipitate loses its Acid properties.

* The Reverse of Manganese, which is coloured by the external, and becomes colourless in the internal flame. Privation of Oxygen blackens this substance, and whitens Manganese.

The

The yellow Calx is alſo ſoluble in Volalkali and retains an exceſs of it. This ſolution affords Acicular Cryſtals, and yet thus alſo an Acid is formed, for the ſolution of theſe Cryſtals turns that of Litmus Red.

If theſe Cryſtals be calcined, the exceſs of Alkali is expelled and the YELLOW Calx, (if the operation be performed in open veſſels, or the BLUE, if in a retort,) is produced.

If theſe Cryſtals be digeſted in the Vitriolic Acid they are converted into the blue Calx, if in the Nitrous or Marine Acids, into the yellow Calx.

If to the ſolution of this fuliginated Calx (the Acid thus formed) a few drops of Nitrous Acid be added, a white precipitate will be produced, which is alſo an Acid, and is the Acid that SCHEELE produced in his experiments.

To conclude the account of the yellow Calx, we need only to add that it blackens by expoſure to the ſun, and alſo by moiſture, or calcination in cloſe veſſels; in this laſt caſe it forms plumoſe Cryſtals like Antimony. Its Specific Gravity is then 5,700. The yellow Calx alſo unites to Sulphur in the dry way, and with it forms a bluiſh black brittle cryſtalized maſs per LUYART.*

With reſpect to the Tungſtenic Acid commonly ſo called, we may remark.

1. That it always appears in the form of a WHITE CALX, tho' the white calx is not always Acid.

2. That it is formed either by the union of the YELLOW CALX WITH AN EXCESS OF VOLALKALI, and this may be called the FULIGINATED

* This however is denied by Gmelin 2 Chym. Ann. 1786. p 120.

NATED CALX; or BY AN EXCESS OF VOLALKALI AND THE ADDITION OF AN ACID, which may be called the ACIDO FULIGINATED CALX; or BY AN EXCESS OF TARTARIN AND THE ADDITION OF AN ACID, which may be denominated the ACIDO TARTARINATED CALX. The two last only, were known to SCHEELE and BERGMAN who supposed them to be simple substances.

The first or FULIGINATED CALX, has the following properties, besides those already mentioned; it precipitates the Vitriolic solutions of Iron, Copper and Zinc, and also of Allum, Nitrated Lime, and Muriated Mercury, and the Acetous solutions of Lead and Copper. And with Limewater it forms Regenerated Tungsten.

The ACIDO TARTARINATED, and ACIDO FULIGINATED calces are said by SHEELE to agree in their properties, but the brothers LUYART remark the following differences.

The Acido fuliginated calx is decomposed by mere boiling; it then becomes emulsive, and blue.

The same happens also when this calx is calcined (But SCHEELE ascribes this property to both calces, § 6.)

By digestion in Vitriolic Acid it turns blue. With fixed Alkalis it emits a Volatil Alkaline smell.

The ACIDO TARTARINATED CALX is fusible PER SE and with the different fluxes presents the same Phænomena as the yellow calx, per LUYART. §. IX. but in §. VII p. 4, they tell us that the yellow calx gives a brownish yellowish Glass with Borax. Consequently so should the the Acido Tartariated Calx, yet SCHEELE §. 5. says it gives a blue Glass with Borax, BERGMAN says a small quantity of it gives a blue and a larger

larger quantity a browniſh yellow colour to Borax. And KLAPROTH aſſures us it gives no colour to borax.*

Calcined, it emits the ſmell of Nitrous Acid, turns yellow, yet on cooling recovers its white colour, but becomes INSIPID AND INSOLUBLE. Here the inſolubility proceeds from the expulſion of the Nitrous Acid as a mere TARTARINATED CALX remains, which is not an Acid. But this mere Tartarinated Calx is fuſible PER SE.

If to the Acido Tartarinated Calx the Vitriolic, Nitrous, or Marine Acids be added the alkaline part becomes ſaturated, and the Calx becomes yellow, and no longer diſtinctly acid.

But if the mineral acids above-mentioned be gradually added to the SOLUTION of Acido Tartarinated Calx, no precipitation takes place, until the Mineral Acids abound and be made to boil; then a yellow Calx falls.

According to SCHEELE §. 5. the ACIDO TARTARINATED CALX precipitates the Vitriolic ſolutions of Iron, Zinc, and Copper white, and the nitrated ſolutions of Silver, Mercury, and Lead, and Muriated Lead, and alſo Muriated Tin BLUE. But does not alter the ſolutions of ſublimate Corroſive, or of Gold.

But according to LUYART §. IX. this Calx does not precipitate the ſolutions of the Vitriols of Iron, Zinc, or Copper, and with him KLAPROTH agrees†.

According to SCHEELE it does not precipitate the ſolutions of allum, or lime-water §. 5. but according to LUYART §. IX. it precipitates Lime-water into a true Tungſten, though not the ſolu-

* 2 Berl. Beob 2 Stuck. 42. and 1 Berl Beob. 191.
† Ibid.

tion

tion of allum, which yet the fuliginated Calx precipitates.

From these various accounts it may be collected that these apparently Acid Calces are not of a fixed nature, endowed with constant invariable properties, and therefore not a fit foundation for sure and invariable conclusions. The YELLOW Calx seems to me to be the true Tungstenitic Acid, tho' by superoxygenation many of its acid properties are disguised. The superfluous Oxygen is in great measure destroyed by Caustic Volalkali, this latter being decomposed, its inflammable part passing into water. Its insolubility resembles that of the Oxygenated Marine Acid, and of the PRUSSIAN Acid, and only differs in degree. Its union with Alkalis, with Lime, and with metals even the Noble Metals, of which an account may be seen in Mr. LUYART's Dissertation, plainly evince its acid nature, for as a simple Calx it could not unite with them.*

* See Cullen's Translation of El'Luyart's Analysis of Wolfram.

SPECIES I.

Mineralized by Oxygen and Lime

TUNGSTEN.

Weiſs Scheele erz of Werner.

Of this there are two Families, the White or Grey, and the Brown.*

FIRST FAMILY.

White or Grey.

White Zingraupen of many.

Its colour is yellowiſh white, more rarely yellowiſh grey, that of the cryſtalized, is pearl grey.

Occurs maſſive, diſſeminated or cryſtalized in acute angled, octohædral generally imperfect cryſtals ſmall or middle ſized.

Luſtre 3. 2. Tranſparency, 2. 3.

Fracture, in ſome directions FOLIATED, the Lamellæ running in two different courſes. In other directions flat or minute CONCHOIDAL, paſſing into the UNEVEN.

Hardneſs from 6. to 7. rarely 9. Specific Gravity 6,0665, BRISSON; or from 5,8 to 6,028

* Though theſe are deſcribed in my firſt volume, yet as both volumes are ſeparately publiſhed, and the 2d may fall into the hands of ſome who have not purchaſed the firſt. I thought it right to repeat the deſcriptions.

which

which is that of the cryſtalized Specimen from SCHACKENWALD, LESKE, O. 3261. GELLERT found that of another Specimen 6,000.

Inſoluble in water, does not effervefce with Acids, but is partially ſoluble therein in a ſtrong heat.

When digeſted with three times its weight of Nitrous Acid or Marine, it aſſumes a YELLOW or whitiſh yellow colour, (the calcareous part being diſſolved).

Heated, it decrepitates, but is infuſible by the blow-pipe or even in the ſtrongeſt heat of our furnaces.

Treated with Borax it melts, but its colour is ſcarcely altered unleſs the quantity of Borax be conſiderable, and then it becomes brown or even black. With Microcoſmic Salt, or Phoſphoric Acid, it gives a blue (SCHEELE ſays a ſea green) glaſs, which diſappears if long fuſed in the external, but re-appears in the internal flame. It alſo melts with Soda, but without altering its colour.

It contains about 30 per cent. of Lime, a little Silex and Calx of Iron, the remainder Tungſtenic Calx.

SECOND FAMILY.

BROWN.

Coffee Brown Goſſan of the Corniſh.

Reddiſh or yellowiſh brown or rather grey variegated with yellowiſh brown often overcaſt with black Manganeſe.

Found maſſive, or forming a brittle maſs of ſmall cryſtaline grains, with browniſh black powder of Mangancſe interpoſed.

Luſtre 2. Waxy. Tranſparency 0.

Fracture, UNEVEN, partly SPLINTERY, ſometimes SLATY.

Hardneſs from 6 to 7. Specific Gravity 5,570, KLAPROTH.

When pulverized and digeſted with Aqua Regia it aſſumes a yellow colour.

KLAPROTH found the grey kind to contain 11,5 per cent. of Lime, 88 of Tungſtenitic Calx, the remainder Argill and Iron Ochre. 4 BERL. BEOB. 320.

SPECIES II.

TUNGSTENITIC CALX, WITH IRON AND MANGANESE, OR IRON SINGLY.

WOLFRAM.

Its colour is brown, or browniſh or greyiſh-black, almoſt quite black, yet ſometimes indiſtinctly variegated.

Occurs Maſſive, or diſſeminated, or cryſtalized in right angled quadrilateral tables, with bevilled edges and blunted corners, or oblong tables, or in ſix ſided middle ſized priſms with two broad and two very narrow oppoſite planes, and ſharply terminated, often indiſtinct.

External Luſtre 2. Internal 2. 3. Coaly or nearly Metallic. Tranſparency 0.

Longitudinal Fracture, FOLIATED ſometimes indiſtinctly, rarely STRIATED. Croſs Fracture, ſmall or fine grained UNEVEN. Fragments 3.

Hardneſs from 6 to 8. Specific Gravity 7,1195 BRISSON. 6,835. EL'LUYART, 5,705 GMELIN.

GMELIN.* 7,000 LEONHARDI.† I found that of the Specimen O. 3265 from ZINWALD to be 7,006. and that of the Specimen O. 3266. from GEIR, to be 7,058.

Streak, dark Reddiſh-brown.

Infuſible by the blow-pipe, and decrepitates. Treated with Microcoſmic Salt, in the external flame it effervefces and gives a pale Red Glaſs, in the Internal darker. With Borax it alſo effervefces and gives a greeniſh-yellow, which in the external becomes reddiſh. EL'LUYART.

Heated ſtrongly in a crucible it ſwells, becomes ſpongy and ſemi-vitrified. ibid.

Projected on red hot Nitre it effervefces with a ſlight blue flame, and then, or when melted with fixed Alkali, if it contains Manganeſe it aſſumes a green colour,‡ but if it contains only Iron a dark-grey §

Digeſted in Marine Acid, it turns yellow (like the firſt Species) and the addition of Cauſtic Volalkali will convert this into white, forming the fuliginated Calx.

The Brother's EL'LUYART extracted from the Wolfram of ZINWALD in BOHEMIA, 65 per cent. of the yellow Calx, 22 of Manganeſe, and 13 of Calx of Iron. However the blue flame it produced in Nitre, and the abſence of Sulphur, ſhews ſome or other of theſe ſubſtances to be in a Metallic ſtate.

* 2 Chym. Ann. 1786. 7.

† 7 Leonhar. Worterb.

‡ Per Wiegleb. 1 Chym. An. 1786. 301.

§ Per Klaproth. 1 Berl Beob. 188

KLAPROTH

KLAPROTH in the Wolfram of POLDICE in CORNWALL found only Tungſtenitic Calx and ſlightly Oxygenated Calx of Iron, with ſome traces of Arſenic. 1 BERL. BEOB. 188.

WIEGLEB alſo found in 400 grains of Wolfram 143 of Tungſtenitic Acid, 128 of Manganeſe, and 44 of Iron, but his Analyſis is not compleat.

Mr. CRELL found alſo the ſame ingredients, tho' ſometimes in different proportions ; he alſo reduced the Calx to a Metallic form, but his thorough knowledge of the numerous fallacies to which experiments of this nature are expoſed, induced him to wiſh a repetition which the ſmall ſtock of this rare Ore he poſſeſſed, has as yet prevented.

CHAP.

CHAP. XIX.

MOLYBDENITE.

Molybdenum of Hielm.

By this name I diſtinguiſh the Regulus produced from Molybdena by the indefatigable ſkill and induſtry of Mr. Hielm

Its colour is externally whitiſh-yellow, but in its Fracture whitiſh-grey.

Luſtre 2. Hitherto procured only in brittle agglutinated maſſes.

Specific Gravity when firſt aſſayed in water, appears variable for ſome days, until its interſtices have perfectly abſorbed that fluid, and then 7,500.

The Nitrous Acid attacks it with effervefcence, and converts it into a Calx, endowed with Acid properties.

The Vitriolic Acid concentrated and boiling, alſo attacks it, and acquires firſt a green, then a blue colour from it, but by long boiling it loſes all colour. The Marine has no effect on it, nor even Aqua Regia, unleſs it contains $\frac{4}{5}$ of Nitrous Acid.

It differs from all other Metallic Subſtances by being nearly infuſible in our furnaces; it is probably the impoſſibility of exhibiting it in the form of a round button, that made Klaproth think he had not ſucceeded in reducing it. However by Mr. Pelletier's account, it was evidently reduced, and Mr. Hielm produced a ſtill purer

purer and more perfect Regulus.* In a red heat it calcines. While in its Reguline State it gives no colour to Borax, which property proves its different ftates.

This fubftance is alfo capable of exifting in the ftate of an Acid.

The Molybdenous Acid is nothing more than the Calx of Molybdenite Oxygenated as perfectly as poffible.

It is generally procured by the defulphuration and Oxygenation of the Sulphurated Ore of this Semi-Metal, namely Molybdena. Now Molybdena may be defulphurated and oxygenated either by combuftion, Detonnation with Nitre, or folution in the Nitrous Acid.

To procure a pure Acid by the Combuftion of Molybdena requires particular attention and much fkill; the procefs hath hitherto properly fucceeded only in the hands of Mr. PELLETIER. By heating Molybdena in perfect contact with the open Air, its Acid or Calx fublimes in the form of white flowers, refembling the Argentine flowers of Antimony, which are formed by an analogous operation. In general thefe flowers are yellowifh or bluifh, either retaining Vitriolic Acid, or not perfectly defulphurated and oxygenated.

The Molybdenous Acid procured by the detonnation of Nitre and fubfequent extrication of the Alkaline bafis, by any of the common Mineral Acids, generally retains fome portion of Alkali which tho' it renders it more foluble than a more perfect Acid Calx, yet in other refpects weakens its Acid properties.

* See 27 Roz. Jour. and Schewl Abhandl. for 1789, 90, and 92.

The

The moſt perfect Acid is that which reſults from the ſolution of Molybdena in the Nitrous Acid, yet to Oxygenate it perfectly, it requires to have twenty times its weight of Nitrous Acid, in five ſucceſſive portions diſtilled over it, being then edulcorated and dried, it is as white as Chalk.*

However it ſtill retains ſome Vitriolic Acid, from which it is in great meaſure purified by repeated fuſion in cloſe veſſels. A more perfect but more laborious mode of purifying it may be ſeen in Mr. HIELM's memoir among theſe of the Academy of STOCKHOLM for 1788.† Perhaps alſo it may be well purified by adding to its ſolution, the ſolution of Muriated Barytes.

The Molybdenous Acid thus purified, is of the Specific Gravity 3,750. If leſs pure its Specific Gravity is lower.

Soluble in 570 times its weight of Water, at the Temperature of 60 degrees of Fahr.

Precipitable BROWNISH-RED, by tincture of Galls, or Pruſſian Alkali. It reddens Litmus, and takes Sulphur from its Hepars. Its affinity to Sulphur, ſeems to ſurpaſs that of any other body to that ſubſtance.

SOLUBLE in Vitriolic Acid, which it renders BLUE when cold, tho' colourleſs when heated, alſo in the Marine, which it renders blue when concentrated and heated. But INSOLUBLE in the Nitrous Acid.

The ſolution of the Molybdenous Acid, acts alſo on the imperfect Metals, as Tin, Zinc, &c.

* See Klaproth's Method. 3 Berl. Beob. 73.

† Page 276. of the German Tranſlation, and Vol. II. p. 306. of the Engliſh Tranſlation of Crell's Journal.

rendering them BLUE, particularly when heated, as they ſtrip it of its Oxygen.

It alſo precipitates the nitrated ſolutions of Silver, Mercury and Lead, and alſo Muriated Lead, and the ſolutions of Barytes in the Nitrous or Marine Acids, but not thoſe of the other Earths. It is more active when heated than when cold. Molybdenated Barytes is ſoluble in cold water.

It unites and effervefces with Alkalis, and with the Earths forms difficultly ſoluble compounds.

Heated in cloſe veſſels it melts; in open, it ſublimes; before the blow-pipe on Charcoal it is ſpeedily abſorbed. With Microcoſmic Salt it becomes GREEN, with Borax GREY, and ſlowly alſo GREEN.

With fixed Alkalis it effervefces but is not diſcoloured.

SPECIES I.

MINERALIZED BY SULPHUR.

MOLYBDENA, OR MOLYBDEN, WASSERBLEY OF THE GERMANS, BLEYERZ OF THE SWEDES.

Its colour is light Lead-grey, often with a ſhade of Red.

Found Maſſive, diſſeminated, or imbedded, rarely cryſtalized, and then in Hexahædral moſtly equilateral tables, ſmall or middle ſized.

Luſtre 3. 2. Metallic. Tranſparency 0.

Fracture curved FOLIATED. Fragments 1. Its lamellæ ſlightly flexible.

Hardneſs

Hardneſs 4. Specific Gravity 4,7385. BRISSON. 4,569. KARSTEN. I found that of the Specimen O. 3211. which was not quite pure 4,048.

Streak Bluiſh-grey and Metallic, powder-bluiſh.

Feels ſomewhat greaſy, ſtains the fingers, and marks bluiſh-black.

Effervefces with warm Nitrous Acid, leaving a greyiſh Calx undiſſolved. Inſoluble and Indecompoſable in the Vitriolic and Marine Acids, tho' in a boiling heat it gives a green colour to both if concentrated. Inſoluble in Alkalis in the moiſt way.

In a low red heat and open veſſels it remains unaltered, in a ſtronger it is decompoſed in ſome meaſure, with a Sulphureous ſmell, and part ſublimes in the form of white or yellow flowers which become darker on cooling, the Reſiduum appears yellowiſh and ſemi-vitrified.

In cloſe veſſels it is not altered.

Before the blow-pipe on a Silver Spoon it emits a white ſmoke, which condenſes into a white powder, that becomes blue in the internal, and loſes again its colour in the external flame.

By Borax and Microcoſmic Salt it is but little altered, but with fixed Alkali it effervefces, and gives a REDDISH Pearl colour.

In Molybdena the Metallic part or Molybdenite is in a Metallic ſtate, as PELLETIER has well remarked.

The experiments of ISELMAN, diſproving the exiſtence of Sulphur are far from being concluſive.*

* See 34 Roz. Jour. 127.

CHAP. XX.

SYLVANITE.

By this name I denote the new Semi-metal of FACEBAY, to which no name has as yet been given, tho' it is evidently different from all other known Metallic Subſtances.

I call it Sylvanite, from its being found in TRANSYLVANIA.

Its colour is dark grey, or white, not ſo clear as Reguline Antimony, inclining to red; but this ſhade is not ſo ſtrong as in Biſmuth.

Found diſſeminated or imbedded.

Luſtre 2. Metallic.

Fracture, broad or granularly foliated.

Hardneſs ſomewhat malleable. Specific Gravity 5,73, but after having been twice fuſed 6,343

Heated, it melts as eaſily as Lead, gives a thick white ſmoke, and at laſt a browniſh flame.

In cooling, its ſurface is fretted with a tendency to cryſtalization. By continued heat it intirely evaporates. On Charcoal it depoſits a thin-layer of grey powder, internally reddiſh and yellow.

It detonates with Nitre, and the Calx that remains is ſoluble in Acids. This Calx alſo melts eaſily before the blow-pipe into a pearl coloured glaſs.

It eaſily amalgamates with Mercury by ſimple trituration.

It combines with Sulphur and forms with it a ſtriated maſs like Sulphurated Antimony.

It

It is ſoluble in a very ſmall degree in concentrated Vitriolic Acid in cold, or a low digeſting heat and the ſolution is crimſon red, but by the ffuſion of water, or by a ſtronger heat it s prec.p tated.

It is alſo ſoluble though in a very moderate degree, yet with heat and effervefcence in Nitrous Acid, and the ſolution until it heats is greeniſh.

Its beſt ſolvent is Aqua Regia compoſed of four parts Nitrous Acid and one of Sal Ammoniac, the ſolution is yellow.

It is inſoluble in the Muriatic Acid.

Its Calx is of an Acid nature and unites to Alkalis. It is alſo ſoluble in Acids.

This ſingular ſubſtance was at firſt taken for native Regulus of Antimony, afterwards for ſulphurated Biſmuth; for the latter it could well be miſtaken as its Specific Gravity is not very different, but it differs widely in its relation to Nitrous Acid, the colour it aſſumes with the Vitriolic, its ſolubility therein in cold, &c. With the former it has many properties in common, but differs in many others as is evident.

For the above experiments and many more we are indebted to Mr. MULLER * he found it to contain a ſmall proportion of Arſenic, and of NICKEL and alſo of gold. BERGMAN found it alſo to contain a little Zinc, but theſe mixtures ſeem to be merely caſual.

* Phificaliſche Arbeit. paſſim. 2 Raab. 468.

C H A P.

CHAP. XXI.

MENACHANITE.

This ſubſtance was diſcovered in the valley of MENACHAN in CORNWALL by Mr. M'GREGOR, and thence derives its name. He ſubjected it to a ſeries of curious and intereſting experiments of which he had the goodneſs to ſend me an extract. They are related at large in ROZIERS Journal for 1791. p. 72. and 152.

Its colour is black

It is found in ſmall grains reſembling Gunpowder, of no determinate ſhape and often mixed with a grey ſand of great ſubtilty.

Eaſily pulverized. Specific Gravity 4,427. Its powder magnetic.

Expoſed to the blow-pipe it does not decrepitate, Microcoſmic Salt ſcarcely affects it, yet acquires a greeniſh colour from it while hot which becomes brown on cooling. Borax quickly diſſolves it and alters its colour in the ſame manner. In a high heat it ſlightly agglutinates and acquires a ſlight increaſe of weight. Does not detonate with Nitre.

With two parts fixed Alkali it melts into an olive coloured maſs from which Nitrous Acid precipitates a white earth, or rather Calx, which has not the properties either of the Tungſtenitic or Molybdenic Calces.

In the moiſt way Alkalis do not affect it.

It is inſoluble in Acids without particular management, but by ſuch management it is found to conſiſt of about $\frac{46}{100}$ parts of Iron ſlightly oxygenated

genated and $\frac{45}{100}$ of a white Calx whofe properties will prefently be mentioned, and a few grains of Silex and a fufpicion of Manganefe.

Properties of the Menachanitic Calx.

If Menachanite be finely pulverized and mixed with concentrated Vitriolic Acid into a mafs not too liquid and then heated to drynefs it becomes blue, if to this blue mafs water be added, it gradually becomes yellow, and on fhaking the liquor a yellow folution is obtained, this operation is repeated until the Acid is no longer difcoloured, thus the Iron is feparated and the refiduum is the white Calx which on Calcination becomes brownifh red and is then foluble in Vitriolic Acid. This folution in a boiling heat depofits a confiderable proportion of the white Calx. It is alfo precipitable by fixed Alkalis.

If Nitrous Acid be frequently abftracted from finely powdered Menachanite the ferruginous part becomes foluble in water, and the Refiduum is reddifh brown. The Marine Acid alfo takes up moft of the ferruginous part, from which it may be freed by Cauftic Volatil Alkali.

The Calx obtained by depofition from the boiling Vitriolic Acid, or purified by the Marine Acid, is fufible by Borax, to which it gives a green colour while hot, which vanifhes when cold, but it is infufible by Microcofmic Salt.

It is alfo in fome degree foluble in Nitrous Acid, and ftill more in Marine Acid, except it were precipitated from the Vitriolic Acid by fixed Alkalis and heated to incandefcence for then it is nearly infoluble in both thefe Acids.

The Vitriolic Acid diffolves this Calx more copioufly, and with greater eafe than any other Acid, and yet if it be precipitated by an Alkali,

kali, and calcined, it acts upon it with greater difficulty.

Oxymuriatic Acid and Aqua Regia ſcarcely affect it.

Its ſolution in the Vitriolic Acid, is precipitated deep green, by Pruſſian Alkali, white by a common Alkali, and becomes Orange coloured with Tincture of Galls.

Fixed Alkalis do not unite to it, either in the moiſt or dry way, hence it is not of an Acid nature.

It refuſes to unite to Sulphur.

It ſeems diſpoſed to aſſume a Metallic form, with proper fluxes, but the experiments made with this view, do not ſeem to have been carried far enough.

CHAP.

CHAP. XXIII.

TITANITE.

The Metallic nature of this ſubſtance, which many have called a Red Shorl and has been mentioned as ſuch in my Firſt Volume p. 271. has been lately diſcovered by the indefatigable KLAPROTH.* It ſeems to me a ſubſtance intermediate between a ſemi-metal and an earth, but farther experiments particularly its miſcibility with other Metallic ſubſtances muſt decide.

It is found according to BARON BORN at RHONITZ. According to the others at BOINICK in HUNGARY.

Its colour is browniſh red.

It occurs cryſtalized in right angled quadrangular priſms longitudinally ſtreaked or furrowed and nearly ½ inch in length, or leſs, often acicular and ſeated on Shiſtoſe Mica alternating with Quartz.

Luſtre 3. Tranſparency 0. except in thin pieces and then 1.

Croſs fracture FOLIATED, the longitudinal, is intermediate between the FOLIATED and the UNEVEN, and in ſome places minute CONCHOIDAL.

Fragments 3. Its powder brick or Orange Red.

Hardneſs 9. brittle. Specific Gravity 4,18.

Expoſed to a porcelain heat, in a clay crucible, it remained unaltered, only its colour was ſome-

* Klapr. 233.

what browner. But in a coal crucible it burſt into angular fragments, loſt its luſtre and colour, and became pale brown.

Treated with Microcoſmic Salt before the blow-pipe it was taken up but not melted by that Salt. But it yields to Borax and alſo to Soda, giving with the former a hyacinth, and with the latter a whitiſh red bead.

Neither Aqua Regia nor the Vitriolic, Nitrous or Marine Acids have any effect on it, even when heated.

200 Grs. of it melted in a porcelain crucible with 5 times it's weight of mild Tartarin, formed when cold a denſe greyiſh white maſs whoſe ſurface was acicularly cryſtalized and its fracture fibrous. When diſſolved in boiling water, it ſoon let fall a white ſubſtance which edulcorated and gently dried, weighed 328 grs. and appeared a looſe earth. This I call Titanitic Calx. The Alkaline lye being then ſaturated with Marine Acid depoſited an Argillo Siliceous mixture amounting to about 8 grs. probably derived from the crucible

PROPERTIES OF THE TITANITIC CALX.

It is ſoluble in the Vitriolic, Nitrous and Marine Acids, but by ſpontaneous evaporation forms with all of them a more or leſs clammy maſs which KLAPROTH imputes to ſiliceous earth intermixed with it, for the Nitrous Solution diſcovers ſome few cryſtals when thus evaporated.

Theſe ſolutions are precipitable in light WHITE flocks by mild Tartarin or Cauſtic Volalkali, but browniſh green by Pruſſian Alkali, and browniſh RED by tincture of galls.

Tin

Tin turns the Muriatic ſolution to a bluiſh RED, and Zinc to an Indigo BLUE, this laſt however when heated gradually whitens, leaving a white precipitate, which is re-diſſoluble in Marine Acid, and with Zinc re-produces a blue colour as at firſt. Hence it would ſeem, that the Calx is more compleatly Deoxygenated by Tin than by Zinc, the blue colour being an approach or a ſhade that many ſubſtances paſs thro' before they become Red. It follows that Red is the colour of this Metal in its Metallic State, in ſuch therefore it is when cryſtalized in its native Shorlaceous ſtate

50 Grſ. of this white Calx were by ignition reduced to 38. While hot it was yellowiſh, but like Calx of Zinc, whitened as it cooled. After ignition it becomes inſoluble in Acids; probably from the ſtrength of its accretion Heated on Charcoal it becomes roſy Red, and afterwards SLATE BLUE, and finally melts into an imperfect bead with a fine ſtriated ſurface. With the uſual fluxes, it exhibits the ſame appearance as in its native ſtate. It is Irreducible by the uſual Methods.

It appears to me to reſemble Menachanitic Calx, in many of its properties, perhaps the difference may ariſe from Iron, contained in the latter.

TITANITIC ORES.

CALCAREO SILICEOUS ORE.

The only one yet known (if Menachanite be not one) is that found near PASSAU, diſcovered and deſcribed by profeſſor HUNGER.

Its colour is Reddiſh, yellowiſh, or Blackiſh BROWN, ſeldom whitiſh grey, and then generally exhibits a bluſh of Reddiſh brown.*

It is found maſſive or diſſeminated, but more commonly cryſtalized in obtuſe angled tetrahædral cryſtals, at moſt ¼ of an Inch long, its ſurface generally ſmooth but ſometimes ſlightly ſtreaked, generally ſeated on, or inhering in Gneiſs or Granite.

Luſtre 2. 3. Waxy or approaching to the Metallic. Tranſparency 0. but in thin pieces 1. 2.

Croſs Fracture FOLIATED with little or no Luſtre,† the longitudinal has more Luſtre, and in the maſſive is divergingly STRIATED. Fragments 2. often Rhomboidal.

Hardneſs 9. cuts Glaſs, brittle. Specific Gravity per KLAPROTH 3,510. Gives a whitiſh grey powder.

It is infuſible by the blow-pipe, and alſo when expoſed to a porcelain heat in a clay crucible, but in a Coal crucible, it is converted into an opake black porous ſlag.

By repeated digeſtion in Marine Acid it yields to it about ⅓ of its weight, and the ſolution is yellow.

This ſolution treated with cauſtic Volalkali gives a YELLOWISH clammy precipitate, and afterwards by the addition of Soda a Calcareous Earth.

The yellowiſh precipitate treated with Borax, Microcoſmic Salt, Vitriolic and Marine Acid, Pruſſian Alkali, Tincture of Galls, and Zinc as above mentioned, exhibited the characters of Titanitic Calx.

* 5 Berl. Beobacht. 195.

† Q. The Nature of this fracture is obſcurely expreſſed !

On

On a farther and more exact Analysis KLAPROTH found it to contain 35 per cent. of Silex, 33 of Calcareous Earth, and 33 of Titanitic Calx. The excess proceeds from Water or Oxygen taken up. 1 KLAP. 251.

Before I conclude I cannot omit mentioning an extraordinary substance noticed by Mr. MONNET in the Mines of BRAUNSDORF near FRIBURG, of which it is to be hoped Mr. WERNER will give a fuller account, as he is said to have been present when it was discovered. According to MONNET it was there called FAULEBLENDE having the colour of Blende, (whether yellow, brown or black he does not say,) but much lighter and more brittle, being friable betwixt the fingers, it must however be exceeding light since he at first took it to be a Bitumen. Its Fracture vitreous, shape indeterminate. Fusible PER SE in a very high heat, and viscid when in fusion. Infusible by fixed Alkalis, soluble in the Mineral Acids, and precipitable in the form of a yellow Calx, by fixed Alkalis.

However no Specific conclusions can be deduced from these and some other experiments, which he relates in the Mem. of TURIN 1788. 372. &c.

CHAP.

CHAP. XXIV.

OF THE ANALYSIS AND ESSAY OF METALLIC ORES.

OF THE DETERMINATION OF AN ORE FROM ITS EXTERNAL CHARACTERS

Previous to any Effay or Analyfis of an Ore fome judgement fhould be formed of the nature and fpecies of Metallic Subftance that may be fuppofed to be contained in it; this muft be grounded on the external characters of the Ore, compared with thofe of fome or other of the Ores defcribed in the former chapters of this work; the number of thefe is however fo great that unexperienced perfons (and for fuch this work is principally intended) muft often be much embarraffed to felect thofe with which a comparifon, fhould be made; to affift them as much as poffible in felecting thefe terms of comparifon, I have formed a table of thofe Ores of different Metallic Subftances that refemble each other moft in the two moft ftriking VISIBLE appearances namely COLOUR and LUSTRE; the various fhades of the former to avoid prolixity I have omitted.

COLOUR.	LUSTRE.	
WHITE, OR GREYISH WHITE, REDDISH, YELLOWISH, OR GREENISH WHITE RESPECTIVELY.	*Metallic.*	Gold Ore of Nagaya.
		Platina.
		Native Silver.
		Antimoniated Native Silver.
		Arfenical Native Silver.
		White Copper Ore.
		Arfenicated greenifh white Iron Ore.
		Native Regulus of Antimony.
		Muriated Antimonial Ore.
		Arfenical Pyrites.
		Native Bifmuth.
		White Cobalt Ore.
		Nâtive Manganefe, Q.
		Grey Ore of Manganefe.
		Sylvanite.
	Common, or Waxy refpectively.	Corneous Silver Ore.
		Sparry Iron Ore.
		White Lead Ore.
		Vitriol of Lead.
		Phofporated Lead Ore.
		Corneous Mercurial Ore.
		Phofporated Antimony.
		White Ore of Manganefe.
		Vitriol of Manganefe.
		Vitriol of Zinc.
		Grey Tungftein.
	Null.	Chryftalized Phofporated Lead Ore.
		Calamine.
		Native Calx of Arfenic.
		Bifmuth Ochre.
		Dull grey Cobalt Ore.
		Arfenicated Nickel.
		White Ore of Manganefe.
BLUISH OR LEAD GREY.	*Metallic.*	Gold Ore of Nagaya.
		Platina.
		Argillo Muriated Silver.
		Vitreous Silver Ore.
		Vitreous Copper Ore.
		Magnetic Iron Stone.
		Micaceous Iron Ore.
		Emeril.
		Galena.
		Compact Galena
		Sulphurated Antimony.
		Plumofe Antimonial Ore.
		Sulphurated Bifmuth.
		Sulphurated Nickel.
		Molydbena.

COLOUR.

COLOUR.	LUSTRE.	
	Common, or Semi-metallic respectively.	Emeril. Zinc Spar. Native Calx of Arsenic.
BLUISH OR LEAD GREY.	*Null.*	Upland Iron Ore. Earthy white Lead Ore. Compact Galena (internally). Dull grey Cobalt Ore.
STEEL, OR BROWNISH GREY.	*Metallic.*	Gold Ore of Nagaya. Vitreous Silver Ore. Antimoniated Silver Ore. Plumbiferous Antimoniated Silver Ore Vitreous Copper Ore. Grey Copper Ore. Magnetic Iron Stone. Specular Iron Ore. Micaceous Iron Ore. Tin Pyrites. Sulphurated Antimony. Plumose Antimonial Ore. Native Arsenic. Sulphurated Bismuth. Grey Ore of Manganese. Sylvanite.
	Common.	Fibrous Magnetic Iron Stone.
	Null.	Upland Argillaceous Iron Stone.
YELLOW, OR BROWNISH YELLOW.	*Metallic.*	Native Gold. Native Silver, *tarnished.* Copper Pyrites. Martial Pyrites. Specular Iron Ore, *tarnished.* Blende. Arsenic Pyrites, *tarnished.* Native Nickel.
	Common, or Waxy respectively.	Sparry Iron Ore. Yellow Lead Ore. Corneous Mercurial Ore. Zinc Spar. Phosphorated Antimony. Orpiment.

COLOUR.

COLOUR.	LUSTRE.	
Yellow or Brownish Yellow.	*Null.*	Iron Ochre. Upland Argillaceous Iron Stone. Lowland Iron Ores. Tungſtenic Iron Stone. Earthy White Lead Ore. Calamine. Antimonial Ochre. Biſmuthic Ochre. Uranitic Ochre.
Red, or Brownish Red	*Metallic.*	Lamellar Silver Ore. Light and dark red Silver Ore, *ſcarcely* Cochineal Red Copper Ore. Fibrous Red Copper Ore. Magnetic Iron Stone, *(often internally)* Specular Iron Stone, *tarniſhed.* Red Hæmatites. Compact red Iron Stone. Hepatic Mercurial Ore. Dark Red native Cinnabar. Blende. Sulphurated Nickel. Native Biſmuth, *tarniſhed.* Sulphurated Biſmuth, *tarniſhed.* Sulphurated Nickel.
	Common.	Red Silver Ore. Indurated Brick-red Copper Ore. Compact red Iron Stone. Red Scaly Iron Stone. Tungſtenic Iron Ore. Red Lead Ore. Zinc Spar. Blende. Red Antimonial Ore. Realgar. Cobaltic Germinations. Coffee, or reddiſh brown Tungſten

COLOUR.	LUSTRE.	
Red or Brownish Red.	Null.	Cement Copper.
		Compact Cochineal red Copper Ore.
		Foliated Do.
		Earthy Brick-red Copper Ore.
		Indurated do.
		Compact red Iron Stone.
		Red Iron Ochre.
		Upland Argillaceous Iron Stone.
		Scapiform Iron Ore.
		Lenticular Argillaceous Iron Ore.
		Tungstenic Iron Ore.
		Earthy red Lead Ore.
		Native Cinnabar.
		Cobaltic Incrustations.
		Brownish red Ore of Manganese.
		Red Ore of Manganese.
		Uranitic Ochre.
Grass Green.	Common.	Fibrous Malachite.
		Green Arenaceous Copper Ore.
		Sparry Iron Ore, *tarnished.*
		Phosphorated Lead Ore.
		Arsenicated Lead Ore.
		Micaceous Uranitic Ochre.
	Null.	Compact Malachite.
		Common Mountain Green.
		Nickel Ochre.
Canary and Olive Green.	Common.	Olive Copper Ore.
		Iron Shot Olive Copper Ore.
		Phosphorated Lead Ore.
		Arsenico Phosphorated Lead Ore.
		Blende.
	Null.	Earthy Iron shot Mountain Green.
		Green Martial Earth.
		Nickel Ochre.
Blue, Violet, or Purple.	Metallic.	Purple Copper Ore.
	Common.	Corneous Silver Ore.
		Striated Mountain Blue.
		Blue Lead Ore.
	Null.	Earthy Mountain Blue.
		Blue Martial Earth.
		Blue Cobalt Ore.

COLOUR.

[redacted]

COLOUR.	LUSTRE.	
Brown, or yellowish brown, or Brownish Black.	*Metallic.*	Magnetic Iron Stone (superficially)
		Cement Copper
		Indurated Brick Red Copper Ore.
		Brown Hæmatites.
		Brown Scaly Iron Ore.
		Nodular Argillaceous Iron Ore.
		Blende.
		Wolfram.
	Common.	Common Brown Iron Stone
		Brown Hæmatites.
		Pisiform Iron Ore.
		Sparry Iron Ore.
		Tin Stone.
		Brown White Lead Ore.
		Brown Lead Ore.
		Perigordic Ore of Manganese.
		Coffee Brown Tungsten.
	Null.	Cement Copper.
		Black Copper Ore.
		Brown Iron Ochre.
		Upland Argillaceous Iron Stone.
		Nodular Argillaceous Iron Ore.
		Pisiform Iron Ore.
		Swampy Iron Ore.
		Meadow Lowland Iron Ore,
		Morassy Iron Ore.
		Calamine.
		Brown Cobalt Ore.
		Perigordic Ore of Manganese.
Black.	*Metallic.*	Vitreous Silver Ore.
		Plumbiferous Antimoniated Silver Ore.
		Calciform Silver Ore.
		Sooty Silver Ore, internally, when scraped, or cut.
		Scoriaceous Silver Ore.
		Cement Copper.
		Micaceous Iron Ore.
		Magnetic Iron Sand.
		Black Iron Stone.
		Black Lead Ore.
		Blende.
		Phosphorated Antimony.
		Black Manganese.
		Sulphurated Uranite.
		Wolfram.

COLOUR	LUSTRE.	
BLACK.	*Common.*	Corneous Silver Ore.
		Swampy Iron Ore.
		Tin Stone.
		Corneous Mercurial Ore.
		Blende.
		Wolfram.
	Null.	Cement Copper.
		Black Copper Ore.
		Sparry Iron Ore.
		Tin Stone (Amorphous)
		Native Æthiops.
		Native Regulus of Arfenic
		Black Cobalt Ochre.
		Black Ore of Manganefe.
		Menachanite.

The Ochres of different Metallic Subftances having often the fame colour, and being of an Earthy confiftence and Fracture (as the Greenifh yellow Ochre of Bifmuth and Uranite) are difficultly diftinguifhed except by Chymical tefts.

ORES

ORES THAT GIVE FIRE WITH STEEL.

Antimoniated Native Silver.
Indurated red earthy Copper Ore, sometimes
Copper Pyrites rarely, and only in its passage to or from Martial Pyrites.
Magnetic Iron Stone.
Specular Iron Ore
Brown Hæmatites
Compact Brown Iron Stone, sometimes
Iron Pyrites
Red Hæmatites
Compact Red Iron Stone.
Emeril.
Tungstenic Iron Ore.
Common Tin Stone.
Fibrous Tin Stone,
Galena rarely, and by reason of Quartz internally.
Calamine, rarely.
Zinc Spar, rarely.
Compact Sulphurated Antimony when impure.
Striated Sulphurated Antimony when impure.
Arsenical Pyrites.
Argentiferous, ditto.
Dull Grey Cobalt Ore.
White Cobalt Ore.
White Calx of Manganese, rarely.

A GENERAL VIEW OF THE SPECIFIC GRAVITIES OF ORES OF DIFFERENT METALLIC SUBSTANCES

Freed as much as possible from Stony or Foreign Substances.

Native Metals are here ommitted.

THE SPECIFIC GRAVITY OF GOLD ORES, if such they can be properly called, reaches from 5,7 to 10,6.

The Blendes or Ores of other Metals that contain it in any notable proportion are heavier than usual.

That of SILVER ORES, from 4,7 to 10,6; the scoriaceous and Mordore are much lighter, the former being only 2,17, and the latter 0,9.

That

That of COPPER ORES, from 3,5 to 5,6; the earthy blue, green and red, have not been tried.

IRON ORES, worth employing from 3,2 to 5,1.

TIN ORES, that of Tin Pyrites 4,35; of the others from 5,8 to 6,97.

LEAD ORES, from [illegible],8 that of the yellow Ore, to 7,78 the highest of Galena.

MERCURIAL ORES, Native Æthiops 2,233; of the others from 5,4 to 10,2 but most between 7 and 8.

ZINC ORES, from 3 to 4,1; that of the blendes extends from 3,9 to 4,1.

ANTIMONIAL ORES, from 4,1 to 4,5 that of Native Regulus; that of the Ochre not determined.

ARSENICAL ORES, that of the Sulphurated Ores from 3 to 3,5; of the other from 3,7 to 6,5.

BISMUTHIC ORES, the native from 9 to 9,5; of the Sulphurated from 4,3 to 6,4; that of the Ochre not determined.

COBALTIC ORES, of the earthy from 2,5 to 4; of the others from 5,3 to 6,3.

NICKEL ORES, 6,6; that of the Ochre not determined.

URANITIC ORES, that of the Sulphurated 7,5; of the others, not determined.

TUNGSTENITIC ORES, from 5,8 to 7,1.

MOLYBDENA, from 4,5 to 4,7.

SYLVANITE, from 5,7 to 6,3.

MENACHANITE, 4,427.

The STRIATED TEXTURE is most remarkable in Ores of Hæmatites, Antimony, and Manganese.

[illegible]

Having from the obſervation of the colour and Luſtre approached in ſome meaſure to the determination of the Ore, we may narrow our inquiry ſtill farther by comparing the external characters of the Ore to be examined with thoſe of that Species of Ore which this obſervation has pointed out, and we may approximate ſtill nearer by examining and comparing the reſults it preſents with Acids, &c. and the blow-pipe. If all theſe appearances coincide with the ſuppoſed GENUS and SPECIES of the Ore we may proceed to the Eſſay in the dry way or its Analyſis in the moiſt way as will be ſhewn in the following ſections.

NOTE. To render theſe Eſſays more concluſive, they ſhould be made on the beſt, worſt and midling ſpecimens, obſerving which ſort abounds moſt in the mine, and upon this, and the probability of its continuance to yield, the intrinſic value of the ſubſtance, the expences of raiſing, working, fuel, carriage, &c. the value of the mine depends.

SECTION I.

All that need be faid of Gold Ores and Platina, may be feen in the firft and fecond Chapter.

OF SILVER ORES.

SPECIES I.

FIRST FAMILY.

NATIVE SILVER, PURE OR NEARLY SO.

1. The Proportion of Arfenic contained in this Ore, being exceeding fmall, is beft determined by weighing the Silver before and after fufion, as the Arfenic is Volatilized.

SECOND FAMILY.

AURIFEROUS NATIVE SILVER.

2. This is analyzed by Nitrous Acid, which diffolves the Silver, and leaves the Gold in the form of a black powder: this powder melted with Borax, appears with its genuine colour. If there be not twice as much Silver as Gold in the Alloy, Nitrous Acid
3. will not totally diffolve it. The Silver may afterwards be precipitated by common Salt, of which (if pure) 100 grains afford 235 of muriated Silver, and 100 of this contain 75 of Silver. (how this is reduced will

4. be

4. be ſhewn No. 23.) Or by a poliſhed plate of Copper, the ſolution being well diluted; or the Acid may be ſeparated by diſtillation, and the Silver reduced by mere heat.

THIRD FAMILY.

Cupriferous Native Silver.

5. This alſo is to be diſſolved in Nitrous Acid, and the Silver precipitated by a poliſhed plate of Copper; ſtill however ſome particles of Copper adhere to the precipitated Silver, from which it may be ſeparated by digeſtion in diſtilled Vinegar or Volalkali.

6. Hildebrand adviſes the ſeparation of Silver and Copper to be made by diſſolving the alloy in Aqua Regia formed of equal parts of the ſtrongeſt Nitrous Acid, (whether free from Vitriolic Acid or not) and of the ſtrongeſt Marine Acid. Here the Marine Acid takes up the Copper, and part of it unites to the Silver which it precipitates, and decompoſes the Vitriol of Silver, if any ſhould be formed; to be certain that the whole of the Silver is precipitated, he adds more Marine Acid, as long as any precipitate appears, this muriated Silver he revives by fuſion with dephlegmated Soda, as will be ſeen No. 23.*

7. The Copper in the ſolution may then be precipitated by a poliſhed plate of Iron.

8. Mr. Keir of Bermingham propoſes another method of effecting this ſeparation viz. by diſſolving the alloy in a mixture of eight

* 1 Chym. Ann. 1794. 486.

or ten parts Vitriolic Acid, 1,844 and one of Nitre, in a heat of between 100°. and 200° of Fahr. This he tells us will dissolve the Silver, but not the Copper unless Water be added to it. The dissolved Silver may then be precipitated by common Salt as usual.*

9. WENZEL suggests another process, whose effect is the inverse of the last mentioned. To Vitriolic Acid, he adds as much of the Marine, as sensibly to act. This compound MENSTRUUM he tells us will dissolve Copper, but leave Silver untouched.†

10. According to Mr. KEIR, Silver may be precipitated from its solution in Nitrous Acid, by a solution of Vitriol of Iron. Now neither Copper nor any other Metal, but Gold and Mercury can be thus precipitated. Phil. Trans. 1790. 383.

FOURTH FAMILY.

ANTIMONIATED NATIVE SILVER.

11. SELB analysed this Ore by solution in Nitrous Acid largely and repeatedly added, and heated to boiling. The Silver was dissolved, and the Reguline Antimony calcined. This Calx was at first red, but the Silver being wholly taken up by repeated treatment with Nitrous Acid, the Calx became yellowish white. This he reduced by fusion, with four times its weight of black flux, and a little soap.

* Phil. Trans. 1790. 364

† Vervandschaft, 183.

10. He

12. He alſo found Aqua Regia, to act imperfectly on the alloy, even when the Reguline Antimony amounted to $\frac{1}{3}$ or $\frac{1}{4}$ of the whole. By WENZEL's method No 9, the Reguline Antimony ſhould be diſſolved, and the Silver remain untouched.

13. IN THE DRY WAY, treated with Sulphur, the antimonial part unites to it, and leaves the Silver diſengaged.*

They may alſo be ſeparated by fuſion, with four times as much calcined Pot-aſh as the Ore weighs.† This large proportion of flux, taking up the antimonial part, and leaving the Silver as pure as it could be by teſting, this method is the beſt. Or by projecting Nitre on the Silver while in fuſion.

FIFTH FAMILY.

ARSENICO MARTIAL SILVER ORE.

Of this Ore KLAPROTH hath lately given an excellent Analyſis.

14. He firſt freed it from the Calcareous particles of its matrix, by treating it with diſtilled Vinegar. He next digeſted 200 grains of the purified Ore in Nitrous Acid, the filtred ſolution left a Reſiduum, which when dry weighed 71 grains.

15. The ſolution treated with common Salt, afforded muriated Silver, which being

* Lempe. Mag. 9.

† Ibid. 13

filtered off and melted, weighed 28 grains, equivalent to 21 of Silver.

16. The solution then treated with Tartarin, dismissed a spongy reddish precipitate, which in drying became dark brown, and by ignition greenish grey and whitish, and weighed 160 grains. As he then knew it to be Arsenicated Iron, he mixed it with ½ of its weight of powdered Charcoal, and gently ignited it, and this he repeated as long as it smelled Arsenical. The martial part which was then black, he separated by a Magnet.

17. The 71 grains of Residuum above mentioned, he then recured to, digesting them in Marine Acid, to which, towards the end, a few drops of the Nitrous were added; the whole was dissolved except a few grains of a semi-compacted coagulated mass, which proved to be muriated Silver, which reduced by Soda, gave 4,5 grains of Silver.

18. The muriatic solution, treated with Water became turbid, but dismissed no precipitate, but being saturated with Tartarin, a yellowish green substance fell, which collected, dried and ignited, weighed 32 grains. These 32 grains being again treated with Spirit of Salt, upon the addition of Water to the solution let fall a white precipitate, which collected and dried in a moderate heat, weighed 10,5 grains and proved to be Calx of Antimony, accompanied however with some traces of arsenicated Iron: hence he estimates it at 8 grains of Metallic Antimony.

19. The Aqueous muriatic solution, *saturated* then with Tartarin, gave out a reddish spongy precipitate which dried and ignited with

with powdered Charcoal, afforded 18 grains of Calx of Iron.

Hence 100 parts of this Ore, contained 12,75 of Silver; 44,25 Iron, 35 Arfenic and 4 of Reguline Antimony. 1 KLAP. 187.

SPECIES II.

CALCIFORM SILVER ORE.

20. This Ore fhould be treated firft as in No. 11, to feparate the antimonial part, and afterwards, the folution as in No. 5, &c, to feparate the cupreous.

SPECIES III.

FIRST FAMILY.

CORNEOUS SILVER ORE.

21. Mr. BERGMAN to analyfe the cryftalized Ore, requires it to be digefted for 24 hours, in Marine Acid, by which means the Vitriol of Silver is decompofed, and the whole converted into muriated Silver; the fupernatant Acid to be then poured off, the Refiduum well wafhed, and the wafhings added to the liquor. This liquor is now fuppofed to contain the whole of the muriated Silver in folution, and alfo free and difengaged Vitriolic Acid. To feparate this he gradually adds a folution of nitrated Barytes, as long as any precipitate appears. The precipitate wafhed, dried and weighed, will indicate the quantity of Vitriolic Acid, contained in the folution, as 100 parts of Barfo-

Barſolenite contain by his account, 15 of the ſtrongeſt Vitriolic Acid,* a quantity exactly equal to that contained in 48 parts of Vitriol of Silver. For according to him 100 parts of this Vitriol, contain 68,75 of Silver,† and conſequently 31,25 of Vitriolic Acid. (The conſequence is not quite juſt, as will be ſeen in the notes in my ſecond table.) The quantity of Vitriol of Silver being known, that of the muriated Silver is of courſe known, it being the remainder of the whole weight of both. And this Salt contains 75 per cent. of Silver, the remainder being Marine Acid. When this Ore is brittle, he judges it to contain Sulphur, and this he propoſes to ſeparate, by means of Volalkali, which will take up the Corneous Ore, and leave the Sulphur. The proportion of Acid and Metal, may be found more exactly by the ſecond table given at the end of this Treatiſe.

22. To analyſe a fragment of the compact maſſive Ore, preſerved in the Mineral Cabinet of DRESDEN, KLAPROTH inſerted 200 grains into three times its weight of pure Nitrous Acid, and boiled the Acid, which barely ſeparated 4 grains of browniſh red Ochre left on the filter, and when treated with Cauſtic Volalkali it depoſited 5 grains more of the ſame; the reſiduary Ore, on which the Acid had no effect, being re-

* This determination is faulty, as will hereafter be ſhewn.

† In Vol. 3d. p. 20. he allows Vitriol of Silver 66,7 per cent. of Silver, and in the Table Vol. 2 p. 391, he allows it 74,6 of Silver per cent

duced

duced by Soda, afforded 133 grains of Silver.

2. To difcover the proportion of Acid or Acids more exactly, he mixed 200 grains of the Ore, with 600 of the pureft Tartarin, melted them in a glafs retort, and diffolved and filtered the melted mafs. The Refiduum on the filter fufficiently edulcorated, and heated with NITROUS ACID, afforded a brown folution furmounted with a wax red foam, and left a brownifh red powder, which digefted in Aqua Regia left a white Refiduum, which was muriated Silver, with fome ftony fubftance; when reduced it afforded 1 grain of Silver. From the folution in Aqua Regia, Volalkali precipitated 7 grains of Calx of Iron.

The Nitrous folution he precipitated with Common Salt, the muriated Silver thus obtained afforded when reduced, 134,5 grains of Silver. The folution thus freed from the Silver, being treated with Cauftic Volalkali, afforded 5 grains Calx of Iron.

To difcover the Acid contained in the Ore, he now returned to the filtered folution of the Alkaline mafs, and faturating it with diftilled Vinegar, found it to become turbid, and to depofit about 3,5 grains of Argill. After which he evaporated the folution to a dry faline mafs, and treating it with Alcohol, feparated the acetated Tartarin. The Refiduum afforded 117,5 grains of muriated Tartarin; this he diffolved, and by treating the folution with muriated Barytes, obtained a precipitate weighing about 3 grains, which he judged to contain

tain about half a grain of mere Vitriolic Acid, and might have formed 1,5 grains of Vitriolated Tartarin, which deducted from the above mentioned 117,5 grains, left 110 of mere muriated Tartarin, which he deemed to contain about 42 of the strongest Marine Acid.

23. IN THE DRY WAY, HILDEBRAND decomposes this Ore, without any loss of Silver, in the following manner:

1. He covers the bottom of a crucible, with dephlegmated Soda, to the thickness of an Inch nearly, and compresses it, by stamping with a pestle.

2. He triturates two parts of the dried Soda, with one part of the Ore, and then gradually wetting them, forms them into a paste of a globular form, which he inserts into the crucible, covering and filling all around with dry Soda.

3. He inserts this into another crucible filled with Sand and gently heats it to redness, and afterwards exposes it to the strongest heat. When all is cold he breaks the crucible and finds the Silver reduced.*

24. If the Corneous Ore contains a mixture of the Vitreous Ore, this will be decomposed by ebullition, in strong Nitrous Acid, and the Sulphur thus acidified, detected by the solution of nitrated Barytes.

25. Muriated Silver may also be decomposed by trituration with sulphurated Volalkali, the Marine Acid uniting to the Alkali, and the Sulphur to the Silver; the sulphurated Silver to be afterwards treated as will presently be mentioned.

* 1 Chym. Ann. 1794. 489.

26. According

26. According to LANDRIANI Corneous Silver may be decompofed, by a cauftic fixed Alkali, in a boiling heat.

The Alkaline Silver Ore, diffolved in Nitrous Acid leaves a refiduum, which heated with Soda, affords its Silvery contents.

SECOND FAMILY.

ARGILLACEOUS MURIATED SILVER ORE.

27. KLAPROTH analyfed this Ore, by digeftion and ebullition in Nitrous Acid, which acted weakly on it, and produced no Nitrous Air. The refiduum exhibited an infpiffated clotted Mafs. The folution which was feebly tinged blue, admitted Marine Acid without any fign of turbidity; but being fuper-faturated with mild Volalkali, let fall fome Argill, and the folution became of a darker blue, and invefted Iron, with a thin coat of Copper.

The undiffolved refiduum being dried, he diffolved by agitation in cauftic Volalkali; a few drops of Nitrous Acid precipitated muriated Silver from this folution. Being gently evaporated to drynefs it left pearl grey flexible cryftaline pellicles which gently melted into a vifcid waxy mafs. The Argill alfo melted with Soda left a fmall refiduum of Silver. 1 KLAPR. 137.

SPECIES IV.

SULPHURATED SILVER ORE.

28. To Analyſe this Ore BERGMAN requires it to be boiled with 25 times its weight of dilute Nitrous Acid added in different portions untill the Silver be totally taken up. However I believe ſome of the Sulphur will always be acidified, and being thus converted into Vitriolic Acid, may retain part of the Silver; if ſo, it will be found either in the ſolution or in the waſhings, and may be detected by Nitrated Barytes. The ſilver may then be precipitated by common Salt, the precipitate waſhed dried and heated to 212 degrees, contains about 75 per cent. of Silver, as already ſaid.

If any other metal then exiſts in the ſolution, Pruſſian Alkali will detect it, and Volalkali or Soda will precipitate the earths.

29. The undiſſolved Sulphur is beſt eſtimated by weighing it when well dried, together with the ſiliceous reſiduum, and then burning it off; the weight of the ſiliceous part deducted from that of the whole gives that of the Sulphur, to which the acidified part muſt be added.

30. IN THE DRY WAY the Silver is freed from Sulphur by melting it, with $\frac{1}{7}$ of its weight of filings of Iron; but as the Silver may thus receive ſome contamination, perhaps it were better to treat it when red hot with Nitre. If there be but a ſmall quantity of Sulphu-

Sulphurated Silver, the Sulphur may be expelled merely by a flow heat.

SPECIES V.

Light Lamellar Silver Ore.

31. This confifts of the Sulphurated Ore mixed with Argill and Calx of Iron, and therefore may be treated as the former fpecies, but it is faid alfo to contain, at times, Lead and Manganefe, in fuch cafe the Lead will be detected in the muriatic precipitate, by its acicular appearance, its folubility in water, and its infolubility in Volalkali; and hence can be feparated by means of either, but beft by boiling water.

32. After the precipitation of the Silver and Lead from the Nitrous Solution by common Salt, and Marine Acid (as common Salt does not decompofe the whole of the lead, at leaft if both folutions be not well heated,) the liquor fhould be concentrated to make it depofit the whole of the muriated Lead, or treated with Glauber Salt to convert this into Vitriol of Lead, which may then be feparated from any mixture of Calx of Iron or Manganefe by folution in hot water and filtration. The Manganefe and Iron if any remain in the folution fhould be precipitated by Pruffian Alkali and feparated as will hereafter be fhewn No. 123, &c. &c. No. 257, &c. The Argill may then be freed from the folution by Volalkali or Soda.

33. In the dry way, this and moft other Ores are effayed by cuppellation with different

 portions

portions of Lead or Litharge, as may be ſeen in GELLERT, CRAMER, &c.

SPECIES VI.

SOOTY SILVER ORE.

34. If this Ore contains only Silver and Galena, they are to be diſſolved in dilute Nitrous
35. Acid, as in No. 28; the Lead and Silver precipitated and ſeparated as in No. 32 and 33. If it contains ſulphurated Silver, Iron and Reguline Antimony, the boiling Nitrous Acid will calcine the two latter, and leave them undiſſolved, particularly if after cooling, the ſolution be expoſed for ſome time to the Air. Common Salt will precipitate the Silver from the filtered ſolution, and ſhould any Earths or Copper or Iron ſtill remain in it, Pruſſian Alkali will precipitate the latter, and Soda the former; the pruſſiated Metals heated to redneſs, and when cold treated with Volalkali, will yield to it the cupreous part, leaving the Ferruginous ſingle.

36. The undiſſolved reſiduum of the firſt ſolution, containing the Antimonial and Martial Calces, ſhould be diſſolved in Aqua Regia, conſiſting of two parts Marine and one part Nitrous Acid; the addition of Water will precipitate the Antimonial part, and Pruſſian Alkali the Martial. If any Earths remain in ſolution, Soda will free them; what eſcaped ſolution in Aqua Regia, is moſt probably Siliceous.

SPECIES

SPECIES VII.

Antimoniated Silver Ore.

Klaproth analysed this Ore, which had always before been thought to contain Arsenic, with particular attention to that circumstance.

37. He subjected 100 parts of it to the action of dilute Nitrous Acid heated to ebullition and repeatedly added, until its black colour disappeared, and until the residuum became greyish yellow; this residuum filtered off and dried weighed 26 grains.

38. From the solution (which was greenish) two drachms of Common Salt in solution, precipitated 87,75 of muriated Silver, which after reduction afforded $\frac{3}{4}$ of its weight of pure Silver.*

39. The solution thus freed from Silver he supersaturated with Caustic Volalkali; it then deposited 5 grains of a grey substance, which on burning Coals gave out an Arsenical Smell, and being redissolved in Nitrous Acid, and separated from that Acid by hepar Sulphuris, afforded a smutty brown precipitate, and with Prussian Alkali, a Prussian Blue, which after torrefaction was Magnetic,

40. and hence was judged to be Arsenicated Iron. Note that as he suspected the presence of Lead in the solution, he essayed it before the addition of Volalkali, with Glauber's Salt, but obtained no precipitate.

* The Common Salt by way of precaution, was purposely added to excess.

The

41. The Volalkali having imparted a bluiſh tinge to the liquor, he ſuſpected it to contain Copper. To detect this, he ſaturated it with Vitriolic Acid, and eſſayed it by a poliſhed plate of Iron, but the cupreous tinge was ſo ſlight that none could be collected.

42. He then turned his attention to the undiſſolved reſiduum No. 37, digeſting it in Aqua Regia, as long as any ſolution could be perceived. What now remained undiſſolved appeared to be SULPHUR, and being waſhed and dried weighed 13 grains, leaving after combuſtion 1 grain of Quartz.

43. Of the 26 grains therefore of which the reſiduum No. 37, originally conſiſted, 13 were thus accounted for, and 13 more re-

44. mained in the ſolution in Aqua Regia, No. 42. Theſe were precipitated WHITE by the addition of 16 or 20 times as much Water, and when collected and dried, became YELLOW when heated to redneſs, but gave no ſign of Arſenic or of any volatil Ingredient. Placed on burning Coals, this Calx was reduced partly of itſelf, but ſtill more by the mixture of Soda, and afforded a button of pure Reguline Antimony, and as ſuch, diſappeared in a higher heat, in the form of a grey ſmoke, depoſiting acicular cryſtals on the edges of the Coal. Theſe 13 grains were therefore Calx of Antimony, equivalent to 10 of Reguline Antimony.

SPECIES VIII.

FIRST FAMILY.

Light grey Plumbiferous Antimoniated Silver Ore.

Light Weifsgultig of 1 *Klaproth.* 168.

45. To difcover the contents of this Ore, Klaproth digefted 400 grains of it, firft in five times its weight of Nitrous Acid, and afterwards in twice its weight of that Acid, and then diluted this laft portion of Acid, with 8 times its weight of Water, and continued the digeftion. The undissolved residuum wafhed and dried, weighed 326 grains.

46. The folution treated with Common Salt, depofited 1^{o} muriated Silver, and over that acicular cryftals of muriated Lead; thefe laft he diffolved and feparated by adding a fufficiency of boiling Water. The muriated Silver heated with double its weight of Soda, afforded 81,5 grains of Silver.

47. The folution from which he had obtained both thefe muriated Metals and the aqueous folution of muriated Lead being united, he farther concentrated by evaporation, and adding a folution of Glauber's Salt obtained 45 grains more of Vitriol of Lead, equivalent to 32 of Metallic Lead.

48. Having thus freed the folution both from Silver and Lead, he treated it with Volalkali, and obtained a pale brown precipitate, weighing

ing 40 grains, as this appeared to consist of Argill and Iron, he redissolved it in Nitrous Acid, and precipitated the Iron by Prussian Alkali, and the Argill by Soda. The Argill, heated to redness, weighed 28 grains, consequently the Calx of Iron weighed $40-28=12$ grains equal to 9 grains of Metallic Iron.

49. He now returned to the undissolved residuum, No. 45, this he repeatedly treated with boiling Marine Acid, which on cooling constantly deposited acicular crystals which he separated from the filter by the same Acid heated.

50. After all that was Metallic appeared to be taken up, there remained 51 grains apparently Sulphureous, but which on combustion left one grain of Silex.

51. Tho' the muriatic solution No. 49, had deposited a quantity of acicular crystals, yet it still contained more muriated Lead, he therefore reduced it to one half by distillation during which it deposited still more of that Salt; he consequently continued the distillation until no more crystals were deposited. The crystals mixed with double their weight of black flux he reduced in a crucible smeared with Charcoal; the Lead thus obtained weighed $160\frac{3}{8}$ grains; from this, on cuppelation an Arsenical smoke arose and $\frac{1}{8}$ of a grain of Silver remained.

52. The solution from which this Lead was obtained, being now treated with sulphurated Volalkali deposited an orange coloured precipitate, denoting the solution to contain muriated Antimony; a copious affusion of

water

water cleared it of moſt of this, and Soda of the remainder. The Antimonial Calx thus obtained, he reduced to a maſs with Spaniſh Soap, mixed it with black flux in a lined crucible, and by fuſion obtained a regulus weighing 28,5 grs. which in a ſtrong heat totally evaporated, three grains more were found in the cover of the crucible.

53. In this Analyſis it is, as the ingenious author obſerves well worthy of notice that ſo ſmall a quantity of Reguline Antimony ſhould ſhield ſo large a proportion as 160 grs. of lead from the action of the Nitrous Acid, an effect never before obſerved.

SECOND FAMILY.

Dark Grey Plumbiferous Antoniated Silver Ore.

Dunkles Weiſſgultig of Klaproth.

54. This Ore being at preſent ſcarce, Klaproth employed in its Analyſis only two hundred grains, theſe he digeſted in three ounces of ſtrong Nitrous Acid diluted with an equal weight of water, and obtained a colourleſs ſolution from which common Salt precipitated $24\frac{7}{8}$ grains of muriated Silver, (equal 18,5 of Metallic Silver,) and a reſiduum which when dried weighed 132,5 grains

55. This ſolution, being after this treated with a ſolution of Glauber's Salt, afforded 93 grs. of Vitriol of Lead equal 66 of Metallic Lead.

After the separation of both these metals, the addition of Caustic Volalkali produced in the same solution a loose flocky precipitate, which after ignition weighed 6,5 grs. and on further treatment appeared to consist of 4,5 grs. Calx of Iron and 2 of Argill.

56. The residuum of 13 ,5 grs. being treated with Marine Acid, was dissolved all to 52 grs. This residuum being heated was consumed, leaving only 8 grs. consequently it contained 44 of Sulphur; of these 8 grs. Marine Acid dissolved 6,5 grs. 1,5, of Silex remained

Both muriatic solutions being united were evaporated untill crystals began to appear. When cold, and the mother liquor poured off, the crystals were washed with a mixture of one part Marine Acid and two of spirit of Wine, when dry they weighed 22,5 grains, and prove to be Muriated Lead, equal 16 of Metallic Lead.

The mother liquor poured of, being diluted with water deposited Calx of Antimony, which dried in a proper heat weighed 56 grs. equal 43 of Reguline Antimony. 1 Klapr. 175.

SPECIES IX.

Cupriferous Sulphurated Silver Ore.

57. This consists of Sulphurated Silver and Sulphurated Copper, both are to be taken up by dilute Nitrous Acid, heated if necessary as it most probably is, and the weight of the Sulphur had as in No. 27. and 28.

58. The

58. The ſolution being well diluted the Silver and Copper may be ſeparated by a poliſhed plate of copper whoſe loſs of weight ſhould be noted; and the Argentine contents being ſeparated by filtration and well waſhed, the cupreous contents may be obtained by a poliſhed bar of Iron, or, if free from earths, rather by Soda, and the weight loſt by the plate of Copper ſubtracted from that of the precipitate. The Argentine precipitate may after waſhing be melted with Borax.

SPECIES X.

RED SILVER ORE.

FIRST FAMILY.

Light Red.

59. As this Ore was always ſaid to contain Arſenic as well as Sulphur, and to union with both its colour was attributed, Klaproth digeſted it for ſome days in ſix times its weight of a mixture of moderately ſtrong Nitrous Acid, 1,350, diluted with an equal weight of water, and after this digeſtion diluted it ſtill farther, and heated it to ebullition When it had cleared he poured of the ſolution and adding the ſame quantity of freſh dilute Acid as at firſt, he continued the digeſtion for ſome time, then filtered of, edulcorated and dried the residuum.

60. The ſolution (which was colourleſs) being reduced by evaporation to a 6th or 8th part, depoſited on cooling copious, granular,

 greyiſh

greyish white, heavy shining crystals which were VITRIOL OF SILVER. Having redissolved them in hot water, and added the re-
61 mainder of the Nitrous Solution, he precipitated the Silver by Marine Acid. The liquor then contained no other foreign substance, but Vitriolic Acid.

62. He next examined the undissolved residuum No. 59. This had the appearance of a loose ash grey powder, he treated it with a mixture of its own weight of Nitrous Acid, and five times its weight of Marine Acid, digesting in a gentle heat for half an hour, and after diluting it with half its weight of water, filtered, edulcorated and dried the RESIDUUM, which turned out to be Sulphur with a small proportion of muriated Silver, which remained after the Sulphur was burned off.

63. The solution in Aqua Regia, thus obtained, he concentrated by evaporation, and then by a copious affusion of water there resulted a white precipitate, which proved to be CALX OF ANTIMONY, for treated with Tartar and Charcoal it afforded a REGULUS which evaporated as such on burning coals and left one grain of Silver.

64. The above solution which afforded this Antimonial Calx, and the former No. 61. from which the Marine Acid had separated muriated Silver, being distilled untill white vapors began to appear, left concentrated Vitriolic Acid in the retort, for being diluted and treated with muriated barytes it afforded when dried 19¼ grs of Baroselenite.

65. Some doubt might arise, (and WESTRUMB entertained that doubt,) whether the Vitriolic

lic Acid might not have resulted from the acidification of the Sulphur during the solution in Nitrous Acid; but when we consider the dilute state of that Acid, the gentle manner of conducting the operation, and the transparency and total want of Metallic Lustre in the Ore, no reasonable grounds for such suspicion can remain. Besides KLAPROTH obtained the Vitriolic Acid by digesting the Ore in the Marine Acid singly. 1 Chym. Ann 1792. 323.

This Analysis varies so much from that of BERGMAN, who seems not barely to have devised it, as he must have done, that of many other Ores, but to have actually executed it, that it seems worth while to inquire into the reason of this deviation. In the 2d Vol. of his works, p. 305, he expressly tells us, that in the pellucid crystals of this Ore, he found 60 per cent. of Silver, 27 Arsenic, and 13 Sulphur. As to the argentine contents, and even as to the quantity of Sulphur, the variation is not greater than may be expected in different specimens; as to the substitution of Arsenic for Regulus of Antimony, it has been supposed that it was the DARK RED Family of this Ore which he examined, and not the LIGHT RED which was the subject of KLAPROTH's Analysis, and that the former really contains Arsenic and not Antimony.

But it seems to me much more probable that BERGMAN, having dissolved a great part of the Ore in dilute Nitrous Acid, he judged the grey heavy crystals No. 60. deposited by the solution when cold or perhaps evaporated to some degree, to be Arsenic, from a preconceived opinion derived from

from HENCKEL, that this Ore contained that semi-metal, as KLAPROTH also must have done, had he not tried to precipitate it by the Marine Acid. Then having treated the residuum with boiling Aqua Regia (so he directs p. 417) the powder it deposited he took also to be Arsenic, though he acknowledges it was very sparingly soluble in water; now if we add the 20 grs. thus found to 6 or 7 perhaps of the grey crystals that first appeared we shall have 26 or 27 of the supposed Arsenic which he states. As to the Vitriolic Acid he did not suspect any. LOWITZ however has rendered this point still doubtful; for he tells us, that in many specimens he examined he constantly found Sulphur and Arsenic, and no traces of Antimony. These specimens should be compared with those examined by KLAPROTH.*

66. IN THE DRY WAY these Ores are Essayed by cuppellation.

SPECIES XI.

SCORIACEOUS ARSENICAL SILVER ORE.

67. This seems an aggregate of many Ores, consisting of Silver, Iron, Arsenic, Cobalt, and Sulphur. Mr. SCHREIBER has not sufficiently detailed its Analysis, which perhaps may be undertaken, thus, let the whole be repeatedly treated with hot Nitrous Acid, which will take up the Silver, Cobalt

* 1 Chym. Ann. 1794. 183.

and

and part of the Iron and Arſenic; let the filtered ſolution be treated with a ſolution of common Salt, untill the Silver be precipitated.

68. If the whole be then evaporated to dryneſs in a heat of 240°, from the dried maſs hot water will extract the Arſenic, Acetous Acid will take up the Cobalt, leaving the Sulphur and Iron, which may be ſeparated by ſlow combuſtion, afterwards by Ignition the quantity of Iron will be found.

The Arſenical part may previouſly be ſeparated in great meaſure by diſtillation.

SPECIES XII.

Bismuthic Silver.

69. Diſſolved in Nitrous Acid, much of the Biſmuth may be ſeparated by the affuſion of water, and the Silver then precipitated
70 by Copper or Common Salt. Or Wenzel's compound Muriatico Vitriolic menſtruum may be tried, as he tells us it diſſolves the Biſmuth and not the Silver.

REMARK.

71. If the quantity of Silver in a Metal or Ore be alone sought, we may ſtop at the operation in which it is detected; in the foregoing proceſſes its ſeparation we have conſtantly ſeen effected by ſolution of common Salt, or a poliſhed plate of Copper, or Volalkali, or water when mixed with muriated lead. Or in the dry way by cuppellation.

72. To

72. To find the ARGENTINE CONTENTS OF STONY SUBSTANCES through which Silver is often difperfed, thefe fhould be reduced to fine powder, and the Silver extracted by amalgamation as mentioned in the firft Chapter. Or the powder may be mixed with double its weight of Litharge or Red Lead, and melted in a luted crucible in a forge. The crucible fhould be thrown while yet hot into water, broken, the vitrified matter taken out, and mixed with twice its weight of black flux, placed in a large crucible and fufed, thus a button of lead containing the Silver will be obtained, from which the Silver may be extracted either in the moist way as in No. 45. and 47. Or by cupellation.

73. PURE SILVER is had from an alloy of Silver and Copper, by folution in Nitrous Acid, and precipitation of the Silver, by a folution of Common Salt; 640 grains of pure Common Salt will precipitate 480 of Silver. 100 grains of ftandard Silver, contain only 7,5 or 8 of Copper, which will be feparated from the muriated Silver for the moft part, and if any adheres to the precipitate yet (if all Coaly fubftance be excluded) it will not mix with the Silver in fufion. Hence HILDEBRAND found that precipitation by Common Salt was not abfolutely neceffary, for the folution in Nitrous Acid may be precipitated by Soda, an excefs of which may even be added as it takes up the Calx of Copper. The precipitate fhould be wafhed before the filtration as well as after, and then mixed with $\frac{1}{4}$ of its weight of calcined Borax, and melted in a covered crucible.

The

The Regulus thus obtained, ſhould be well freed from the adhering Calx of Copper, and digeſted for an hour or two in boiling Vinegar, to take up that contained in its
74. rugoſities.* Mr. KEIR found, that from a ſolution of Silver in the Nitrous Acid, the Silver may be precipitated in its Metallic form, by a ſolution of Vitriol of Iron. As this happens only to Gold, which cannot be expected in the Nitrous ſolution, and to Mercury which is ſcarce ever mixed with the Silver, it follows that by this method, more eaſily than by any other, Silver may be obtained perfectly pure.

SECTION II.

OF COPPER ORES.

SPECIES I.

NATIVE COPPER.

75. According to BERGMAN, this Ore ſometimes contains Gold, ſometimes Silver and Iron. Theſe are diſcovered and ſeparated by ſolution in boiling Nitrous Acid, the Gold remaining undiſſolved in the form of a reddiſh black powder; the Silver may be precipitated by a poliſhed bar of Copper, &c. and the Iron ſeparated by repeated ebullition and expoſure to the Air.

* 2 Chy. Ann. 1794. 16.

SPECIES II.

Copper Calces, or Calciform Ores.

76. Theſe are variouſly oxygenated, if in any notable proportion, the ſmell of a ſmall quantity of Marine Acid digeſted over them, may diſcover it; ſome contain fixed Air which may be caught in a pneumatic apparatus. If they contain any Earth, as many do, the whole may be diſſolved in Nitrous Acid, and ſeveral of the Earths will be left undiſſolved.

77. The Nitrous ſolution may then be treated with Pruſſian Alkali, which will leave only the Earths in ſolution, which ſolution, together with the undiſſolved reſiduum No. 76, may then be examined, as ſhewn in my firſt volume. Or the whole may be precipitated by Soda, and the cupreous part extracted from the precipitate, by Volalkali, which will leave only the Earths and Calces of Iron to be examined and ſeparated.

78. In the dry way Calciform Ores ſhould firſt be gently roaſted to dry them and expell fixed Air, for nothing is gained by waſhing them. They ſhould then be mixed with twice their weight of fixed Alkali, $\frac{1}{4}$ their weight of Roſin or Pitch, and melted in a covered crucible in a forge; 10 minutes fire is ſufficient, or as ſoon as the effervescence is over, and the Metal

79. flows quietly and without any bubble. However even this method gives the Metallic contents below the truth; Thus Fourcroy treating

treating the green Sand of PERU in this method (to which Ore, by reaſon of the Acid, it contains, which reſtrains the action of the Alkali on the Copper, this method is moſt favourable) obtained only 45 or 46 per cent. of Copper, whereas, by the liquid Analyſis, it was found to contain 56 per cent

SPECIES III.

SULPHURATED ORES.

THE FOUR FIRST FAMILIES.

80. BERGMAN adviſes theſe Ores, well pulverized, to be boiled in five times their weight of concentrated Vitriolic Acid until reduced to a dry maſs, and then treated with warm Water, until the Metallic contents are all diſſolved, (which Volalkali either poured
81. on the laſt waſhings, or digeſted on the maſs will diſcover.) The ſolution then largely diluted is to be precipitated by a poliſhed clean plate of Iron, (at leaſt double the weight of the Ore,, and at laſt heated to ebullition; if the Copper adheres too ſtrongly to the Iron, more dilution is requiſite, the precipitate ſhould ſpeedily be waſhed and dried elſe it would be acted on by the Air, but not in too ſtrong a heat, for the ſame reaſon. If the precipitate be contaminated by Iron, it muſt be re-diſſolved as before.

82. If Gold or Silver be ſuſpected or ſought in theſe Ores, they ſhould be diſſolved in Nitrous Acid as in No. 75.

83. The Sulphur is indeed moſtly deſtroyed in this proceſs, or evaporated, hence it would be better to expell it firſt by torrefaction, as KLAPROTH did in treating the Corniſh Ore, and then apply the Vitriolic Acid as above.

As Copper Ores of this Species are very common in this Country, and the determination of the exact proportion they contain of great importance, I ſhall ſtate ſome other methods of determining it, which have been

84. employed by eminent Metallurgiſts. 1ſt. BRANDT remarks that ſome of theſe Ores abound ſo much in Iron, that there is no way of diſengaging the Copper, but by ſcorifying the Iron, and it often happens that the proportion of Sulphur they contain is inſufficient for this purpoſe; in this caſe, after roaſting the Ore in the uſual way, by which much of the Iron is ſcorified, he again mixes the torrefied Ore pulverized, with more Sulphur, and roaſts it a ſecond time, in a heat not ſufficient to burn off he Sulphur, which he encreaſes afterwards until it ceaſes to ſmell Sulphureous; he then treats it with Nitrous Acid, which takes the Copper and very little of the ſulphurated Iron, moſt of which may be ſeparated by boiling the ſolution, or by Volalkali added to exceſs, which will retain the Copper, but precipitate the Iron. In the firſt caſe the Copper may be precipitated by a plate of Iron or Soda, and in the ſecond, by diſtilling off the Alkali.*

* The Copper ſeparated from Nitrous Acid by Iron, is never perfectly free from Calx of Iron, and hence Bergman uſes the Vitriolic Acid, and Fordyce re diſſolves the Copper in Vitriolic Acid, as will preſently be ſeen.

85. 2. He alſo extracted Copper from the torrefied Ore, by treating it with mild Volalkali, (which he found to act quicker than the Cauſtic,) firſt without heat, and after thus obtaining as much as poſſible, then by a digeſting heat gradually increaſed and continued many days. This method he found very ſucceſsful and to yield pure Copper, the Alkali he ſeparated by diſtillation.

86. 3. If Zinc be ſuſpected in theſe Ores (which I believe is ſeldom or ſcarce ever contained in them, tho' its Ore may be MIXED with the genuine Copper Ore,) it may be diſcovered by diſſolving the Ore gently roaſted, in Nitrous Acid, and precipitating, firſt the Copper by Iron, and then the Iron by boiling the ſolution until it is precipitated; the filtered ſolution then treated with Soda will diſmiſs the Zinc in the form of a white Calx, which Cauſtic Volalkali will take up.

87. IN THE DRY WAY we may remark that the BLACKER theſe Ores are after torrefaction, the richer they are in Copper, and the REDDER they are the more they abound in Iron; if YELLOWISH they contain a mixture of Blende.

88. Paſſing over the tedious methods of CRAMER and GELLERT, I ſhall ſtate that of ESCHAQUART (or perhaps more properly of GERHARD) which I have tried and found to yield Malleable Copper at the firſt eſſay.

With one part of the Ore, mix four of dry Nitre, and project the mixture gradually into a red hot crucible in a wind furnace, waiting after each projection until the detonation is over; this being paſſed, the mixture

ture will harden, increaſe the heat until it is ready to melt: then project ſucceſſively a mixture of Tartar amounting to the weight of the Ore, with an equal weight of Common Salt and ½ of pulverized Charcoal; after the whole is projected add four times the weight of the Ore of pounded Glaſs, cover the crucible and heat it ſtrongly for half or ¾ of an hour; take it up, break it, and a button of Copper will be found.*

89. Mr. GERHARD gave a proceſs very ſimilar to this, but he requires the Ore to be roaſted, then mixed with three times its weight of Nitre, and after detonation adds ſtill more, if it ſtill detonates; then takes it up, diſſolves the ſaline part in Water, ſeparates the reſiduum by filtration, dries it and roaſts in a ſtrong heat for half an hour, then mixes it with Glaſs, Borax and Pitch, and ſo melts it. 2 BEYTR. 35.

SECOND FAMILY.

PURPLE COPPER ORE.

90. As this ſeems to be richer in Copper and poorer in Iron than the former, it conſequently requires leſs Nitre when treated in the dry way.

* 3 Helvet. Magaz. 33?.

THIRD

THIRD FAMILY.

Black Copper Ore.

91. Its contents not having been yet accurately found, it ſhould firſt be analyſed in the moiſt way, before the proper proportion of Nitre can be ſettled; in the mean time it may be treated as the next Family.

FOURTH FAMILY.

Vitreous Copper Ore.

92. Klaproth found half an ounce of an Ore of this ſort to loſe about 14 grains by calcination; he then mixed it with its own weight of calcined Borax, half of pounded Glaſs and a quarter of Roſin, placed the mixture in a crucible lined with Charcoal, and covering the whole with Common Salt, gave it a ſtrong heat for half an hour; yet he obtained of Malleable Copper, only 71 grains that is 29,6 per cent. whereas in the moiſt way, by the method No. 83 he recovered 56 per cent. It may be treated alſo with $1\frac{1}{2}$ times its weight of Nitre as in No. 88.

FIFTH

FIFTH FAMILY.

Grey Copper Ore.

93. This besides Copper, contains Reguline Antimony and often Lead, Silver, Iron and Sulphur; its Analysis may be attempted with Nitrous Acid, which by repeated additions, sometimes strong and sometimes weak, hot or boiling, as long as it takes up any thing, will master the Copper, Silver and Lead; the two last may be precipitated by Common Salt, the Silver intirely, the Lead partially. To obtain the whole of it, the filtered solution should be strongly concentrated and treated with Common Salt, the muriated

94. Silver and Lead, are separated by Water, the Copper being thus insulated, is precipitable by Soda or Iron If the solution does not contain much of it Soda is preferable; the precipitate by Soda, washed and dried, should be treated with Volalkali, to separate the Copper from the Argill and Iron, which may be involved in the precipitate.

95. The undissolved residuum may now be treated with Marine Acid, to take up the Lead, that may still remain with the calcined Antimony, and both treated as in No. 49, &c.

96. Sometimes Tin instead of Reguline Antimony is said to be contained in this Ore; when so, it is known not only by its colour, but by the insolubility of its Calx in Aqua Regia, and its fixity when strewed on burning

burning Coals It can be reduced in the dry way.

97. To Analyſe the Ore from KREMNITZ in HUNGARY, and there called WEISSGULTIG. KLAPROTH (who calls it GRAUGULTIG) aſſumed 300 grains of it not perfectly ſeparated from the Matrix, and when minutely pulverized digeſted them in 1200 of Nitrous Acid, and the reſiduum with an equal doſe of freſh Acid, this reſiduum was then of a yellowiſh grey colour and weighed 188 grains, the clear green ſolution treated with Common Salt, depoſited its Silvery contents, which reduced by Soda weighed 31,5 grains.

98. The ſolution being then eſſayed with vitriolated Tartarin, and alſo with Vitriolic Acid, betrayed no Lead; But being ſuperſaturated with Cauſtic Volalkali, it depoſited a looſe flocky browniſh red precipitate, which heated to redneſs, became browniſh black, and weighed 9$\frac{1}{4}$ grains, and being treated with Marine Acid was moſtly diſſolved, leaving only half a grain of Silex; this laſt ſolution, by Pruſſian Alkali afforded a blue precipitate, and this being filtered off, Soda further ſeparated 1,5 grains Argill; conſequently theſe being deducted, the Martial contents amounted to 7,25 grains.

99. The ſuper-ſaturated Alkaline Solution, which had now an azure blue colour, being treated with a piece of poliſhed Iron, gave out 69 grains of Copper.

100. THE 188 GRAINS OF THE YELLOWISH GREY RESIDUUM ABOVE MENTIONED, now remained to be examined. For this purpoſe he digeſted it in a boiling heat,

 with

with ſix times its weight of Marine Acid, and after filtration he edulcorated it, firſt, with more Marine Acid, and afterwards with Spirit of Wine; when dried it weighed 105,5 grains The filtered ſolution which was light yellow, he gently paſſed off by diſtillation of the greater part; in what remained, a few Cryſtals of Muriated Silver appeared, which afforded $\frac{1}{4}$ grain of Silver.

101. The concentrated ſolution being now whelmed with water, depoſited a white precipitate, which when dried in a moderate heat weighed 97,25 grains, and on further trial appeared to be a Calx of Antimony equivalent to 75 grains of Reguline Antimony.

102. What the Marine Acid left undiſſolved, namely the above 105,5 grains being gently heated and inflamed, 80,25 grains remained unconſumed, which proved to be Siliceous. The conſumed part was therefore Sulphur, amounting to 25,25 grains.

103. The Siliceous reſiduum being melted with four times its weight of black flux, afforded about $\frac{3}{4}$ of a grain of Silver. 1 KLAPROTH 179.

104. I ſuppoſe this to be the Ore on which MARGRAF operated Mem. BERLIN 1779.7. as he ſays it was rich, very hard, contained Sulphur and Arſenic (as it was always ſuppoſed to do, until KLAPROTH ſhewed that it was Antimony and not Arſenic that was combined with it,) and came from the Mine of KRÖNER in SAXONY, where this Ore is alſo found. 2 BEROM. Jour. 1790.

1790, 2040. He tells us it loſt by calcination, about $\frac{1}{3}$ of its weight, which agrees very well with KLAPROTH's analyſis of theſe Ores.

105. IN THE DRY WAY and in the experiment that ſeemed moſt productive, he formed a flux conſiſting of equal parts Magneſia, pounded quartz, clay, fluor ſpar, ſteatites and common Chalk; he alſo lined his crucible with a mixture of Clay, and the Coal of Tartar; 60 grains of the torrefied Ore, 6 of the flux, one of common Chalk, and 30 of the Coal of Tartar, afforded him a Regulus of Copper nearly pure, weighing 32 grains, thus the crude Ore afforded about 35,5 per cent. of pure Copper.

106. According to ESCHAQUART this Ore may reduced by his flux in the ſame manner as the Pyritous Ore No. 88.

SPECIES IV.

MURIATED COPPER.

This was analyſed by BERTHOLLET, in the following manner:

107. 1. He diſtilled 100 grains of it with 200 of Vitriolic Acid to dryneſs, extracted the diſſolved part with water, and precipitating the ſolution by a plate of Iron, he obtained 56 grains of Copper, the reſiduum amounting to 13 grains was Siliceous Sand

 108. 2.

108. 2. Diſtilling 500 grains of the Ore, he found them to yield 63 (that is 12,6 per cent) of acidulated water, which ſaturated 3 grains of aerated Alkali * this Alkali precipitated Silver from Nitrous Acid, which was found to be horn Silver, and therefore was the Muriatic But as the whole of the Acid was not thus expelled, to determine its proportion more accurately, he diſtilled 200 grains of the Ore with 100 of Vitriolic Acid, received the vapour in diſtilled water, ſaturated the water with Soda, and thus obtained 48 grains of Salt ſtrongly dried.

109. 3. Theſe 48 grains diſſolved and treated with a Barytic ſolution, afforded 25 grains of dried Baroſelenite, which according to him contain 3,5 of the ſtrongeſt Vitriolic Acid; † and theſe require for their ſaturation 2,5 of pure Soda. Hence he infers that 48 grains of this Salt contained 6 of Glauber's Salt, (viz. 3,5 of Vitriolic Acid, and 2,5 of Soda, conſequently there remained 42 of Common Salt. Now 42 of Common Salt contain by his account about 22 Marine Acid. And as the experiment was made on 200 grains of the Ore, 100 parts of it muſt contain 11 of the Acid.

110. He alſo found it to contain about one per cent of fixed air, the remainder of the loſs he attributes to Oxygen. Mem. Par. 1786. 474.

* He does not mention the Species of Alkali, nor the proportion of fixed air contained in it.

† This is Bergman's calculation, but is contradicted by Dr. Black, Withering, and Klaproth, &c.

Theſe

Theſe calculations are founded on BERGMAN's determinations of the proportion of ingredients in Salts, many of which are now known to be exceedingly imperfect.

111. IN THE DRY WAY, FOURCROY reduced this Ore by a mixture of fixed Alkali and Pitch; taking (probably) half of its weight of the firſt, and ¼ of the laſt, from 100 grains he thus obtained 46 of Copper.

SPECIES. V.

ARSENICATED COPPER ORE.

112. Arſenic has hitherto been diſcovered in this Ore, only by the blow-pipe, the Ore being placed on Charcoal; when the Arſenic was diſſipated, the Copper, at leaſt in the firſt family, was found pure.

IN THE MOIST WAY, the Arſenic being ſuppoſed to be in an Acid ſtate, the whole ſhould be diſſolved in Vitriolic Acid, evaporated to dryneſs, and then waſhed with Spirit of Wine, to take up the Arſenical Acid ſingly. We may alſo try to ſeparate this Acid from a Nitrous ſolution of the Ore, by the Nitrated ſolutions of Lead or Biſmuth as theſe metals are precipitated from the Nitrous by Arſenical Acid. But theſe experiments have not been as yet made.

IN THE DRY WAY, it ſhould be treated as the following.

SPECIES

SPECIES. VI.

White Copper Ore.

113. This should be essayed by solution in strong Nitrous Acid, which will take up the Copper and leave the Arsenic; the small part the Acid may take up, will be precipitated by the affusion of water. The precipitated Arsenic may be taken up by Aqua Regia, or a large quantity of boiling water.

In the dry way, it should first be torrefied with a mixture of Charcoal, and heated to whiteness, to expel the Arsenic or its Acid. And then melted with its own weight of Glass and Pitch, in a covered crucible.

114. Bituminous Marlite, tho' not properly a Copper Ore, but rather the matrix of some Copper Ores, sometimes contains a proportion of Copper worth extracting, and this extraction is actually practiced in the Territory of Mansfeld. Mr. Isleman gives the following method of essaying it.

1. Let four quintals of it pulverized, be heated to redness to consume the Sulphur and Bitumen it contains. Let $\frac{1}{2}$ of the torrefied Ore be digested in a gentle heat with Volalkali for 24 hours, the deeper the blue it assumes the richer it is in Copper

115. 2. The existence of Copper being thus ascertained, let the remaining half be mixed with its weight of black flux, twice its weight of Minium. $\frac{1}{12}$ of its weight of Charcoal,

Charcoal, and 1,5 its weight of decrepitated common Salt, each pulverized apart; let the whole be melted for one hour; a Regulus of Lead and Copper will be ob-
116. tained. To ſeparate theſe let the regulus be hammered into thin plates and diſſolved in dilute Nitrous Acid, and the Lead precipitated by Vitriolic Acid, the Copper may then be ſeparated by a plate of Iron.

117. NOTE 1. To extract Copper from Siliceous Stones. BERGMAN mixes the pulverized Stone with a ſmall proportion of fluor, and then adds Vitriolic Acid, after ſome days, he diſtills the whole to dryneſs. The Fluor Acid opens the Silex and expoſes the Copper to the action of the Vitriolic.

118. NOTE 2. Doctor FORDYCE gives the following proceſs, for eſſaying in the liquid way ALL Copper Ores. To 100 grains of the Ore, finely pulverized, he adds half an ounce of dilute Nitrous Acid, commonly ſold under the name of Aqua Fortis, and half an ounce of Common Spirit of Salt; this mixture he digeſts in a gentle heat, until the efferveſcence (if any) be over, and then in that of ebullition for a quarter of an hour. A ſolution being thus effected, he pours it off when cold and ſettled, and digeſts the reſiduum in an equal quantity of additional compound Acid as at firſt, pours it off, and continues the digeſtions with freſh quantities of Acid, as long as it receives a blue or green colour. Thoſe re-united ſolutions, he at laſt precipitates by Salt of Tartar; he then adds as much Vitriolic Acid as will diſſolve the whole,

whole,* or only leave a white powder, which muſt be filtered off. From the filtered ſolution he precipitates the Copper, by a poliſhed or bright plate of Iron. Phil. Tranſ. 1780. 30.

119. NOTE 3. The magnet will diſcover Iron in Copper, if it amounts to 4 per cent. KINMAN.

SECTION III.

IRON ORES.

SPECIES II.

CALCIFORM ORES.

120. According to BERGMAN all theſe Ores yield to Marine Acid, ſome however ſo ſlowly that they require particular management, which conſiſts in firſt roaſting them with Charcoal. Thus FOURCROY found the Magnetic Sand of PERU nearly inſoluble in that Acid,† but after heating it ſtrongly for two hours with [illegible] its weight of Charcoal, and nearly fuſed it, he found it ſo far deoxygenated, as to yield not only to the Marine but even to dilute Vitriolic Acid. 6 Ann. Chy. 131.

* Yet I ſuppoſe he pours off the ſolution of regenerated Nitre, and Muriated Tartarin, elſe the Vitriolic Acid might react on both, and diſturb the ſubſequent operation.

† It does not appear however, that he reduced it to a powder ſufficiently ſubtile.

Its

Its infolubility however did not in this cafe proceed immediately, and directly from its proportion of oxygen, for fince it was Magnetic this could not be fo confiderable, as to render it, thro' that caufe, infoluble. But its oxygenation rendered it capable of the ftricteft union with Siliceous Earth, and thro' this caufed its infolubility; privation of oxygen loofened this union, and rendered the Metallic part acceffible to Acids.

SECOND TRIBE.

SECOND FAMILY.

We have already feen how KLAPROTH diftinguifhed and feparated the Manganefe in this Ore, but there are various other methods *

121. 1. The prefence of Manganefe is perceived by treating the Ore with Borax before the blow-pipe, for, before the external flame if it contains Manganefe it reddens, but by continued fufion in the internal blue flame, the rednefs difappears, but returns on the addition of a particle of Nitre. It is alfo difcovered by fufion with Tartarin as already mentioned; and alfo by fufion with five times its weight of Nitre, twice repeated if neceffary, for Manganefe will leave a green ftreak on the crucible; the Marine Acid alfo affumes a red

* See BROWN HÆMATITES.

tinge from Iron containing Manganese, but soon turns yellowish.

122. 2. Its presence being thus ascertained, to separate it, let the Iron be rapidly dissolved in strong Nitrous Acid, and dried by exposure to the Air, let the Calx be then treated with dilute Nitrous Acid and Sugar; in a few hours the Manganese will be dissolved, and may be precipitated by a mild fixed Alkali, in the form of a white powder. 2 BERG. 225. However this second solution is not perfectly free from Iron, hence he advises the white Calx thus obtained to be calcined a second time, and again treated with dilute Nitrous Acid and Sugar, it will then take up less of the Iron, and a few drops of Caustic Volalkali will precipitate the small proportion it may yet retain.

123 3. After dissolving the Magnesiated Iron in any Acid, let the solution be precipitated by Prussian Alkali; both Calces may then be separated, as the Prussiate l Manganese is soluble in Water, but the Prussiated Iron is insoluble. Ibid. 423.

124. 4. The Calces of both Metals may also be separated by distilled Vinegar, which takes up the Calx of Manganese and leaves that of Iron, if the Iron be fully oxygenated and not too long left in it, but the Calx of Manganese must be the white Calx recently precipitated, else it will not unite to the Acetous Acid. Hence the solution of Iron in Marine Acid should be precipitated by a mild Alkali, when this effect is desired. However Mr. PORCELL, a

SPANISH

SPANISH chymist of great sagacity suggests, an improvement on this process, he requires the precipitate in which Manganese is suspected, to be treated with distilled Vinegar, and then evaporated nearly to dryness, then Water poured upon it will take up the acetated Manganese and not the Calx of Iron; and if the whole be not extracted by the first operation, it will by a second, 33 Roz. 445.

125. 5. These Calces may also be separated by boiling them in a Lye of Caustic fixed Alkali, which will take up that of the Manganese, and leave that of Iron.

126. 6. FEHLYART separates these Calces by solution in Marine Acid, of which the excess is saturated by Soda, and then boiling the solution. See POST No. 2-7, &c. where some other Methods are also given.

127. IN THE DRY WAY. Magnetic Iron Stones or Ores, and the family in question should, if they perchance contain Sulphur or Arsenic, (which is seldom the case) be first roasted, otherwise not, lest they should absorb oxygen. Take three parts of the Ore, two of Quicklime, two of Fluor, half of well dried Charcoal, and four of decrepitated Common Salt. Let each be ground fine apart, and then well mixed; place them in a crucible lined $\frac{1}{8}$ of an Inch thick with a mixture of three parts Clay, and one of Charcoal, which should also be well dried, lute a cover to the crucible, and when this is also dry commit it to a forge, within 3 or 4 inches of the nozzle of the Bellows; give a gentle heat for $\frac{1}{4}$ of an hour, and the strongest for an hour more.

THIRD FAMILY.

Compact Brown Iron Stone, or Hepatic Iron Ore.

128. Maquart examined a ſpecimen of this Ore from Siberia which he found perfectly ſoluble in Marine Acid, with the aſſiſtance of a moderate heat; 100 grains of it contained about 6,5 of Silex, it was inſoluble in Nitrous Acid.

In the dry way, it may be treated as in No. 127.

SIXTH FAMILY.

Black Iron Stone,

129. It may be treated as in No. 121, &c.

THIRD TRIBE.

FIRST FAMILY.

Red Hæmatites,

130. Gmelin diſſolved this Ore by repeated alternate digeſtion in Marine and Nitrous Acid, and finally in Aqua Regia formed of two parts Nitrous and one of Marine Acid, the metals he precipitated by Pruſſian Alkali, and from the greeniſh colour of the precipitate, and its ſolubility in water infered the preſence of Mangane∫e. By a fixed

fixed Alkali he then precipitated the Argill, which he diſſolved in a Cauſtic fixed Alkaline Lye, and ſaturating this with Nitrous

131. Acid obtained Argill; the Lye duly evaporated, afforded Nitre and alſo flat Cryſtals, which tho' they did not diſturb the ſolution of Vitriol of Iron, yet did after a few hours, that of Lime in Lime-water, and thus indicated a minute quantity of Phoſphoric Acid.

132. The reſiduum which the Alkali left undiſſolved, he next examined by ſix times its weight of ſtrong Nitrous Acid heated to ebullition; it effervefced ſtrongly, and as he ſuſpected Manganeſe he added Gum Arabic, it became fiery red, but as neither Vitriolic Acid, nor Acetoſellated Tartarin diſturbed it, the abſence both of Calcareous and Barytic Earth was evinced; but Pruſſian Alkali cauſed, firſt a greeniſh, and after that a blue precipitate. Still there remained a few grains, which the Nitrous Acid could not maſter, probably by being too highly Oxygenated, for having burned Tallow over them, they became Magnetic.

133. By ſome previous eſſays he found the Ore contained neither Sulphur nor Arſenic, nor Zinc, and when heated in a retort, nothing paſſed, but it rather gained than loſt weight, and became, tho' not black, yet ſomewhat browner, which may be attributed to the Manganeſe.

134. IN THE DRY WAY it may be eſſayed as in No. 127.

FOURTH

FOURTH FAMILY.

Red Scaly Iron Ore.

135. Wiegleb analysed this Ore by digestion in Marine Acid; of 160 grains 60 were dissolved and precipitated by Caustic Vol-alkali; and became Magnetic by having burnt Tallow over them; the residuum was of a shining Coal black colour, detonated with Nitre, and left only a few grains of Sand.

A general Method of Analysing the Two first Species.

136. 1. The proportion of Oxygen may be infered in most cases from their solubility or insolubility in Acids, their relation to the Magnet, the manner they are affected by calcination, the colour they impart to Borax when fused in it, the Air they afford, or refuse, when treated with the Vitriolic or Nitrous Acids.

137. 2. If they are difficultly soluble even in Marine Acid, they should be well pulverized, mixed with $\frac{1}{8}$ of their weight of pure well dried and hot Charcoal, and submitted to the greatest heat of a forge for one hour; thus they will be in great measure deoxygenated, and rendered soluble in dilute Vitriolic, or at least in the Marine Acid, to which if they contain much Manganese they impart at first a red, and afterwards a greenish yellow colour.

138. 3. The ſolution being effected, the Coaly matter they may have taken up, will for the moſt part * remain undiſſolved in the form of black powder, which may be ſeparated by filtration, waſhed dried, weighed and proved by projection on red hot Nitre.

139. 4. The ſolution ſhould be diluted with 10 or 12 times its quantity of pure and warm water, out of which its air had been boiled, and preſerved in a well ſtopped glaſs veſſel for 6 or 8 days: the Sideritic Calx, if any be in the Ore, will within that time, be precipitated, and ſhould be filtered of.

140. 5. An aliquot part of the solution, may then be eſſayed for Barytic Earth, by a ſolution of Glauber's Salt, and for Calcareous Earth, by ſaturated fixed Alkali; if they are found, that par tof the ſolution ſhould be treated, 1. with Cauſtic Volalkali, to throw off every other ſubſtance, and afterwards with Soda, to precipitate them They are ſeparated as ſhewn in Vol. 1.

141. 6. The remainder of the ſolution may then be treated with Cauſtic Volalkali, or if the Calcareous and Barytic Earths be abſent with mild Soda. Thus the Calces of Iron, Manganeſe and Zinc if any, and Argill will be precipitated; the Calx of Zinc will be taken up by digeſting the whole in Cauſtic Volalkali, diſtilled Vinegar will take up the Manganeſe, and leave the Argill and Calx of Iron, which may then be ſeparated as ſhewn in the firſt Vol.

* For ſome may be taken up by the Inflammable Air, if any be produced

142. IN THE DRY WAY, BERGMAN recommends the following as the best flux for all Iron Ores. To 100 grains or parts of the roasted Ore take two of black Flux, one of Tartar, one Sal Ammoniac, one Sandiver, half of Borax, half of Glass ¼ clean Soot, ¼ Charcoal dust, covering the whole with Common Salt, in a crucible well luted. This he found best, not only for the Siliceous, Argillaceous and Sparry, but even for the Pyritous Ores. The heat of a forge WEAK for 5 minutes, MODERATE for 10, VIOLENT for 25 or 30. A heat continued for 5 minutes TOO SHORT a time, causes a difference of from 15 to 20 per cent.; if for 5 minutes too long, the difference will be from 7 to 10 per cent.

When the essay is well made the slag is brown and shining in the fracture, if black, it was faulty.

SPECIES IV.

BLUE MARTIAL EARTH.

143. To examine this Ore KLAPROTH threw 8 ounces of it into 12 of water, in which he gradually dropped 3 of Vitriolic Acid. It then effervesced strongly and gave a brown solution, which being filtered and poured into a large quantity of water, became turbid, and deposited a grey Calx; this dried, weighed 13 drachms, and being

rediſſolved in Vitriolic Acid, and precipitated by water, became pure Siderite. 1 Chym. Ann. 1784. 396.

SPECIES IX.

144. This Ore may perhaps be decompoſed in the moiſt way by Vitriolic Acid, and the Vitriol thus formed heated to dryneſs; yields the Arſenical Acid to Alcohol.

SPECIES X.

Sparry Iron Ore.

145. Let the proportion of fixed Air, be aſcertained by pneumatic diſtillation. Let the reſiduum be diſſolved in Marine Acid, which will take both the Metallic and Calcareous part. Cauſtic Volalkali will precipitate the Metallic, and leave the Calcareous, which Soda will manifeſt.

The Metallic precipitate ſhould then be treated for Mangareſe, as mentioned No. 121, and 122, &c. and hereafter No. 358.

146. Bergman alſo ſeparates the Calx by throwing the calcined and pulverized Ore into dilute Nitrous Acid, and ſhaking it for about ¾ of an hour, as it takes up the Calx firſt, before it touches the Metal, and then pours off the Acid.

147. In the dry way, this Ore needs no Calcination,* and according to Bergman its

* 2 Bergm. 196.

Metallic contents are more accurately found by melting; 100 parts of it covered with calcined Borax in a crucible lined with a mixture of Charcoal and a small proportion of Clay about half an inch thick at the bottom, well pressed, and about $\frac{1}{8}$ on the sides, to which a cover is luted, and heated in a forge.

148. ILSEMAN treats it as in No. 127, only leaving out the Quicklime, and adding more Fluor, in proportion as it contains more Calcareous Earth.

NOTE.

149. RINMAN assures us that the contents of an Iron Ore containing no visible heterogenous matter, may be had very nearly by dividing its Specific Gravity stated in integral numbers by 80. Thus an Ore whose Specific Gravity was 3,893 gave $\frac{3893}{80} = 48,6$, and in reality contained 50 per cent. of Iron. The error was only 1,5 per cent. However this holds only with respect to Ores whose Specific Gravity exceed, 3,6, when less 150 should be the divisor. The error will still be 1,5 or 2 per cent.

In SWEDEN, Ores that contain 50 per cent. are reckoned rich, those that contain less than 30 are not worth the expence. SCHÆFFER §. 299. e.

SECTION

SECTION IV.

TIN ORES.

SPECIES II.

TIN STONE.

150. No effectual method of analysing this Ore in the moist way has as yet been discovered; that proposed by BERGMAN has been unsuccessfully tried both by GMELIN and KLAPROTH.*

151. IN THE DRY WAY, it may be essayed when pulverized, with double its weight of a flux formed of equal parts Pitch and Borax, or Rosin and Borax in a covered crucible lined with Charcoal, placed in a forge, and strongly heated for a quarter of an hour. KLAPROTH reduced the second family of this species, by a mixture of its own weight of Rosin singly without any Borax. 1 BERL. BEOB. 168.

SPECIES III.

152. KLAPROTH having ascertained the presence of Sulphur in this Ore, by distilling it in a glass retort heated to redness, during which treatment a few drops of water passed, which contained Sulphureous Acid, and a slight sublimate appeared, which thrown on a red hot Coal inflamed with a Sulphureous smell, and a slight mixture of the Arsenical; roasted 120 grains of it until it ceased to smell, and yet then

 weighed

* 2 Chym. Ann. 1786. 126. 1 Berl. Beobacht. 165.

weighed 140 grains; these mixed with an equal part of Calcined Borax, $\frac{1}{2}$ of white Glass, and $\frac{1}{4}$ of Rosin, covering the whole with Common Salt, gave a brittle Regulus, of only 10 grains weight.

153. Hence he treated 240 grains of the pulverized Ore with eight times its weight of Aqua Regia formed of 2 parts Marine and 1 of Nitrous Acid. In 24 hours most of the metallic part was dissolved, and the Sulphur floated on the surface. After digestion for two hours in a sand heat he diluted and filtered the solution; 2 grains of Sand remained undissolved, the Sulphur amounted to 75 grains, and being burned left 17 of a black residuum.

154. The filtered solution treated with Tartarin, gave at first a WHITE and afterwards a GREEN precipitate. When this last began to appear he ceased adding the Alkali, collected, edulcorated and dried the WHITE precipitate, re-dissolved it in Marine Acid, and inserted into its solution a cylinder of Zinc, on which the Calx of Tin deposited, and re-assumed its Metallic form, but was mixed with Copper; for which reason he dissolved it anew in Marine Acid, which took up the Tin singly, and left the Copper; the Tin he again precipitated by Zinc, and thus obtained 43 grains, which being covered with Charcoal he reduced by fusion.

155. He now returned to the original solution, on which he had ceased to operate when with Tartarin it began to afford a GREEN precipitate, and saturated it with Tartarin; the green precipitate edulcorated and dried,

dried, and also the 17 grains left after the combustion of the Sulphur, and Copper refused by the Marine Acid in the last operation he treated altogether with Nitrous Acid, and digested them in a strong heat; separated the undissolved residuum by filtration, and precipitated the Copper from its solution by a polished bar of Iron; it amounted to 53 grains.

156. The undissolved residuum on the filter, which was WHITISH GREY he heated to redness with a little Wax; 3 grains only were attracted by the Magnet, and 20 appeared to be mere Calx of Tin = 16 of Metallic Tin.

157. However, as by this method, he obtained only 180 grains of the different substances, from 240 of the Ore, and 60 remained to be accounted for, he judged it defective and began the Analysis once more with 120 grains of the Ore, and six times its weight of the Aqua Regia; he now obtained 43 grains of Sulphur, which after GENTLE combustion left a residuum of 13 grains, of which 8 were dissolved by Aqua Regia and added to the first solution; this solution filtered left 5 grains, which burned with Wax as before, afforded about two grains of Iron.

158. He then precipitated the solution by Tartarin, edulcorated and dried the precipitate, and re-dissolved it in 2 parts Marine Acid diluted with Water (instead of Nitrous Acid which he had employed before.)

159. Into this solution he first put a cylinder of Tin, weighing 217 grains on which 43 grains

grains of Copper were deposited; its purity was examined by digesting it in a strong heat with Nitrous Acid. Thus one grain of Calx of Tin was detected in it, which made its weight at first 44 grains.

160. The Tin cylinder now weighed only 128 grains, consequently 89 remained in the solution.

161. To precipitate the Tin, he immersed in the solution a cylinder of Zinc, and thus obtained 130 grains of Tin in its Metallic State; these he melted with a little Tallow, covering them with powdered Charcoal; washing the Charcoal afterwards, he found one grain of Iron, which brings down the Tin to 129 grains: from which deducting the 89 grains employed in precipitating the Copper, only 40 grains remain to be attributed to the Ore, and one of Calx of Tin. No. 159.

162. In this Analysis only one grain was lost. In the darker Ores he found by treating them as in No. 155, a few grains of Iron, which after a sharp digestion of the cupreous precipitate in Nitrous Acid, remained undissolved.

163. To OBTAIN PURE TIN, in the larger works the only way is to extract it from the purest Ores. But in SMALL QUANTITIES, let the Tin be rapidly dissolved and with heat, in strong Nitrous Acid. Thus some of the Metals it may contain, will be held in solution, and others calcined, but Marine Acid or Aqua Regia will on digestion take up these calces, and after sufficient edulcoration leave that of

of Tin, which may afterwards be reduced in the DRY WAY, as in No. 151.

164. TO DISCOVER ARSENIC IN TIN, dissolve in Aqua Regia, formed of Nitrous Acid of the Specific Gravity 1,316 and Sal Ammoniac, taking 480 parts of the former to 36 of the latter. The Arsenic will remain in the form of a black powder. BAYEN 48. 59. $\frac{1}{256}$ part of Arsenic will thus be detected, and Marine Acid will discover a still smaller proportion Ibid. 76. This powder projected on burning Coals or a red hot Iron, will evaporate in a whitish smoke and an Arsenical smell.

165. TO DISCOVER COPPER IN TIN, let the Tin be dissolved in Nitrous Acid, and the Calx well washed, add the washings to the solution, and concentrate them by evaporation. If Copper be contained in it the liquor will then be BLUE and on evaporating to dryness, Volalkali will take up the Copper. Or else dissolve the Copper in Aqua Regia without heat, dip a piece of Tin in the saturate solution, the Copper will be precipitated upon it. If the Aqua Regia, or Marine Acid employed be very dilute, the Tin will be dissolved and the Copper left at bottom in the form of a black powder, which Volalkali will take up. BAYEN. 162. 163.

166. English Tin often contains both Copper and Arsenic, to discover the proportion, dissolve it in Marine Acid heated; if impure, a black powder will be deposited; expose this to a sufficient heat, the Arsenic

nic will sublime and Volalkali will take up the Copper.

167. To discover Lead in Tin, dissolve it in Nitrous Acid, the Tin will be calcined and the Lead remain in solution, from which a solution of Glauber's Salt will separate it. Much however of the Lead may also be calcined, but Water or dilute Nitrous Acid will take it up, and leave the Calx of Tin.

168. To discover and separate Silver from Tin, the Nitrous, or even Marine Acid may be employed, so that no more of the last is used than will barely dissolve the Tin; this last is even preferable, as the Nitrous always retains some small portion of Tin. Bayen. 199.

169. To discover Bismuth in Tin, dissolve the Tin in Aqua Regia, and precipitate the Bismuth by a plate of Tin. If the Aqua Regia be very dilute, the Bismuth will remain as a black powder. Bayen. 169.

170. To discover Iron in Tin, employ the Magnet, it will attract Tin that contains only two or three per cent. of Iron. Rinman. To separate the Iron, dissolve the Tin in Aqua Regia, and add a solution of pure Vitriol of Copper; the Tin will be precipitated. The Copper and Iron may then be precipitated by Soda, and the Copper extracted by Volalkali, the Iron will remain. Or dissolve the Tin in Nitrous Acid, and digest the Calx in Marine Acid, which will take up the Calx of Iron.

171. To discover Zinc in Tin, dissolve it in Marine Acid, and precipitate the Tin

by

by a piece of Zinc, whoſe weight is known. Or diſſolve it in Nitrous Acid, the Tin will be calcined and the Zinc remain in ſolution.

172. TO DISCOVER REGULINE ANTIMONY IN TIN, a plate of Tin or even of Copper will precipitate the Regulus from the Marine Acid.

IF TIN BE ALLOYED WITH SILVER, REGULINE ARSENIC, OR LEAD, we may perhaps employ WENZEL's Muriatico Vitriolic Menſtruum which he tells us will take up Tin, but not the abovementioned Metals.

173. IN THE DRY WAY, numerous trials were made a few years ago, to ſeparate Tin from Copper in Bells, in order to obtain the Copper pure. As theſe experiments throw great light on Metallic Eſſays, I ſhall here briefly relate the reſults of the moſt important of them.

1. Mr. FOURCROY ſtates that theſe alloys contain about 80 per cent. of Copper, never more; and about 20 of Tin.

2. That by mere expoſure of the pulverized alloy under a muffle to a red heat until it has increaſed in weight about 6 per cent. moſt of the Tin is ſcorified, and by melting it in this ſtate in a ſtrong heat, about 70 per cent. of Copper may be recovered.

3. That by fuſion of the alloy, with about 14 per cent. of Nitre, about 66 per cent. of Copper may be had. By adding Tartarin to the Nitre the Copper melts more eaſily, and in eſſays in the ſmall, Borax ſhould alſo be added.

174. 4. PELLETIER melts the Bell Metal, then projects on it by small portions and at distant intervals, pulverized Manganese in the proportion of about 37 per cent. agitating the melted mass from time to time as the matter becomes pulverulent. Lastly he increases the heat, so as to melt the whole, and thus obtains about 72 per cent. of Copper * In this case the pure air of Manganese Oxygenates or calcines the Tin.

The purity of Tin may be infered from its Specific Gravity, as already mentioned.

SECTION V.

LEAD ORES.

SPECIES II.

CALCIFORM LEAD ORES.

175. These should be dissolved in dilute Nitrous Acid, the weight before and after solution will indicate the quantity of fixed air contained in it, the solution boiled will deposit the Calces of Iron or Antimony, this last indeed is seldom found in it; Caustic Volalkali will precipitate the Lead, after which it may be essayed for Calcareous or Barytic Earths by Vitriolic Acid or Soda; if Argill be expected, another portion of the solution may be precipitated with Vitriolic Acid to separate the Lead and other Earths, after which Caustic Volalkali will separate the Argill.

* 9 Ann. Chym. 338. Nearly about the same time, viz. in June 1791. I employed and not unsuccessfully a similar process in reducing a very ferruginous Copper Ore.

176. WESTRUMB analysed the WHITE LEAD SPAR OF BLEYFIELD in the upper HARTZ, as follows: He diſſolved without the aſſiſtance of heat 5 0 grains of the Ore in about 1000 of dilute Nitrous Acid, half a grain of Calx of Iron remained undiſſolved.

To the filtered ſolution he gradually added dilute Vitriolic Acid; when the precipitation ceaſed, and a few drops of the concentrated Acid diſcovered none, he filtered off the precipitate, and after edulcoration and deſiccation found it to

177. weigh 559,5 grains. To the ſolution concentrated by diſtillation, and after rediſſolving the depoſit of Nitrated Lead formed in it, he added Vitriolic Acid and thus obtained a precipitate which waſhed and dried weighed 11 grains, in all 570,5 grains.

178. The ſolution thus freed from Lead, he farther concentrated, and by adding Cauſtic Volalkali, got about half a grain of Iron, after which mild Alkali cauſed a precipitate, which heated to redneſs weighed two grains, readily diſſolved in water, and therefore was Lime.

179. He then evaporated the whole to dryneſs, but obtained neither Phoſphoric Acid, nor any other matter.

180. As he ſuſpected however that the Vitriolic Acid, might with the Lead, have alſo precipitated ſome Calcareous Earth, he pulverized the precipitate of 570 grains, waſhed it ſeveral times with boiling water; in theſe waſhings neither did Sulphurated Volalkali indicate any Lead, nor Cauſtic Volalkali any Argill, but

 mild

mild Soda difengaged a white Earth, which after incandefcence weighed 2,5 grains, and was mere Lime.

181. Laftly, the Vitriol of Lead treated with black flux afforded 406 of Metallic Lead. The lofs was only 1,5 grains.

182. IN THE DRY WAY, melting it with 2,5 times its weight of black flux, WESTRUMB obtained 75 per cent. of Lead. Whereas in the moift way, he obtained 81 per cent. Melting it with Charcoal and Pot-Afh, in a crucible lined with Clay and Charcoal, he obtained only 63,5 per cent. If the Ore be poor it may require 4 or 5 times its weight of black flux.

183. With refpect to the YELLOW ORES OF THE SECOND FAMILY, MONNET found that fuch as contain the Calces of Iron or Antimony are moft advantageoufly treated IN THE DRY WAY, by mixing them with Common Galena, or Martial Pyrites. Mem. Turin. 1788. 369.

SPECIES III

PHOSPHORATED LEAD ORE.

184. KLAPROTH analyfed the Green Lead Spar of Zfchopau after BERGMAN'S method. Diffolving two ounces of it in 14 of dilute Nitrous Acid, (one part of the Acid being mixed with 3 of water) by long continued digeftion; 14 grains of Calx of Iron remained undiffolved, of which, 12 after combuftion of Wax over them, obeyed the magnet.

The

The ſolution farther diluted, was treated with dilute * Vitriolic Acid as long as any precipitation appeared. The Vitriol of Lead waſhed and dried, weighed 534 grains. As he now ſuppoſed all the Lead taken up, he added to the ſolution the water that had waſhed the Vitriol of Lead and diſtilled the whole to about $\frac{1}{3}$ but there then appeared a large depoſit of Cryſtalized Nitrated Lead which the Phoſphoric Acid it ſeems had protected from the Vitriolic. Theſe Cryſtals were diſſolved in warm water, and again precipitated by Vitriolic Acid, and thus 360 grains more of Vitriol of Lead were procured The ſolution however from which theſe were procured was again diſtilled, and a new depoſit of Nitrated Lead diſcovered; which treated as before afforded 94 grains of Vitriol of Lead. The ſolution was then evaporated nearly to dryneſs, but ſhewed no depoſit; therefore the heat was continued and increaſed, until all traces of Nitrous or Vitriolic Acid diſappeared, then however 2 grains of Vitriol of Lead appeared, to get rid of which, the concentrated fluid was again diluted with water, and theſe two grains filtered off; after which the whole was evaporated until it ceaſed to ſmoke, and was of the thickneſs of an oil; it then became faint OLIVE
185. GREEN, and weighed 180 grains. The Vitriol of Lead weighed 990 grains; the quantity of concentrated Vitriolic Acid employed in forming it, amounted to 300

* Oil of Vitriol mixed with 3 parts water.

grains,

grains, and the quantity of Lead contained in the 990 grains of the Vitriol, amounted to 962 grains

186. The 180 grains of Inspissated Phosphoric Acid, he converted into Microcosmic Salt, by dissolving it in water and adding alternately Mineral and Volalkali, evaporating and chrystalizing; he thus obtained 280 grains of chrystalized Microcosmic Salt. The first shoot of Crystals was pure and white, but the liquor afterwards became greenish, and when diluted and filtered, left 10 grains of a Slimy earth, which flowed thick with a Phosporic glare on Coal, and at last melted into a greenish vitreous bead The filtered liquor treated with Prussian Alkali afforded a precipitate, which heated to redness, and after combustion of graese over it, afforded 1,25 grains of Magnetic Calx of Iron.

187. FOURCROY has given a very ingenious but much more complicated mode of effecting this analysis; to avoid prolixity I shall give only his application of it to the Ore of EHRLENBACH in ALSACE.

188. 1. To 100 grains of the pulverized Ore he added Marine Acid slightly diluted, and heated it to 212°.

189. 2. The solution when cold, presented acicular Crystals of Muriated Lead; these he separated by decantation; the decanted liquor he evaporated to $\frac{1}{4}$, to get rid of the excess of Acid, then poured it on the Crystals,

Cryſtals, and added a ſufficiency of water to re diſſolve them.*

190. 3. This done, he added as much Cauſtic Volalkali as precipitated the whole of the Lead, and thus ſaturated not only the Marine Acid united to the Lead, but alſo the free Phoſphoric Acid contained in the liquor which he had evaporated to $\frac{1}{4}$. No. 189.

191. 4. The Calx of Lead thus precipitated, weighed after edulcoration and deſſiccation 81 grains, this he again diſſolved in Marine Acid, evaporated the ſolution nearly to dryneſs, and treated the maſs with Spirit of Wine, and after the evaporation of the Spirit of Wine, obtained what it had taken up, namely MURIATED IRON, which he re-diſſolved in Water, and by addition of Pruſſiated Lime he got 4 grains of Pruſſian Blue, which he deemed equivalent to one grain of Metallic Iron.

192. 5. There remained then (ſubſtracting this grain of Iron) 80 grains of Calx of Lead, which he eſtimates at 71,11 grains of Metallic Lead.

193. 6. He now returned to the Phoſphorated Ammoniac No. 190, on this he poured Lime Water as long as any precipitation appeared, the precipitate of Phoſphorated Lime thus obtained, weighed 37 grains, and by his eſtimation contained about 15 of Phoſphoric Acid.

* The decompoſition of Phoſphorated Lead by Marine Acid is ſinglar, as Bergman found the Phoſphoric Acid to expel the Muriatic, from Lead. 3 Bergm. 455.

194.

194. Laftly he warns thofe who chufe to repeat his experiments, that tho' the Marine Acid expells the Phofphoric from Lead at the heat of 212°, as in No. 188, yet in a higher heat (as 245°) the Marine Acid is expelled, and the Lead reaffumed by the Phofphoric. 2 Ann. Chy. 216.

IN THE DRY WAY, this Ore may be reduced by the black Flux.

195. BINDHEIM, after finding that this Ore loft 12,5, per cent. by ignition for ¼ of an hour, treated 100 grains of it which had not been ignited, with Dilute Nitrous Acid, and by digeftion obtained a green folution, which on filtration depofited 3,5 grains of Silex and 2 of Calx of Iron.

By treating the folution with Vitriolic Acid, and feafonably concentrating the liquor, he obtained a precipitate of Vitriol of Lead, which when dried weighed 105 grains and afforded by reduction with black flux 64 of Lead.

The liquor from which this Vitriol was had, being evaporated to drynefs and expofed two days to the Air attracted moifture, and had the confiftence of an Oil, and weighed 36 grains. This he diluted, and faturated with mild Volalkali, which produced a green precipitate of 8 grains, which by reduction appeared to be Copper.

The liquor faturated with Volalkali he evaporated and heated to rednefs, the Volalkali being thus expelled, the Phofphoric Acid remained in a dry ftate. 5 Berl. Beob. 178.

SPECIES

SPECIES IV.

Arsenicated Lead Ore.

196. This has not as yet been analyfed, perhaps it may be foluble in dilute Nitrous or Muriatic Acids, if fo, the Lead may be precipitated by the Vitriolic, as in the former cafe.

SPECIES V.

Arsenicated and Phosphorated Lead Ore.

197. To analyfe this Ore, Fourcroy diffolved 100 grains of it in 288 of fmoking Marine Acid diluted with 288 of Water in a heat of 234° Fahrenheit, in cooling it depofited Muriated Lead in quadrangular prifms, and being evaporated ftill farther depofited more Cryftals, the evaporation was continued until by the addition of a few drops of Vitriolic Acid no precipitate appeared *

198. The Muriated Cryftals collected weighed 100 grains; and having re-diffolved and precipitated them by Volalkali, he found the precipitate to weigh 50 grains, and

* Yet Scheele found the Arfenical Acid to precipitate Lead from the Marine. §. 28. D.

having melted it on Charcoal, he obtained 42 of Metallic Lead.

199. The liquor decanted from these Crystals, being evaporated to dryness, left a yellow residuum of the weight of 49 grains, from which Alcohol extracted 6, and the Spirit, being evaporated, these were dissolved in Water and precipitated by Tartarin and afforded 4 grains of Calx of Iron.

200. The 43 grains of dry matter which now remained, he found to be strongly Acid, hence he re-dissolved it, saturated it with Volalkali, and after due evaporation obtained two sorts of Salt, one crystalized in Rhomboids, the other in flat square plates. These exposed to the blow-pipe on Charcoal, exhaled a white smoke that had the smell and properties of the Calx of Arsenic: when this vapor ceased, what remained melted into a vitreous transparent globule which weighed 14 grains, deliquesced, and was sensibly Acid. Of the 42 grains therefore, 29 were Arsenical Acid, and 14 Phosphoric Acid. 2 Ann. Chy. 32.

201. Some time after, however he discovered some errors in this Analysis. 1. He thought the quantity of Lead (No. 198.) should have exceeded 42 grains, as part of it is always volatilized by fusion on Charcoal, part sinks into the Coal, and part is volatilized by the Marine Acid. 2. In evaporating the liquor No. 199. he thinks part of the Phosphoric Acid must have evaporated also, as this Acid, he says is not so volatil, as is commonly imagined.

imagined, part alſo muſt have been volatilized when expoſed to the blow-pipe on Charcoal, hence he thinks the proportion of it in the Ore greater, and that of the Arſenical Acid lower than he had ſtated. 2 Ann. Chy. 210. Upon the whole it appears to me that the exiſtence of the Arſenical Acid, is not ſufficiently proved, ſo alſo the volatility of the Phoſphoric Acid, when in ſolution, and not originally derived from the Oxygenation of Phoſphorus, is far from being proved; tho' when heated on Charcoal, part of it is certainly volatilized.

SPECIES VII.

Molybdenated Lead Ore.

202. Lead in this Ore, being united to an Acid, hitherto very indiſtinctly known, its Analyſis ſeemed beſet with difficulties, which were happily vanquiſhed by Klaproth, in the ſimpleſt manner.

203. Having purified the Ore, from the Calcareous Matrix and Calx of Iron adhering to it, by the reiterated affuſion of very dilute Nitrous Acid, from which the Vitriolic precipitated it as a Selenite, and the Marine took up the Calx of Iron, that waſhed off, he waſhed and dried the Ore, and melted 120 grains of it, with 120 of Tartarin.

204 The melted maſs he diſſolved in Water, and ſaturated the filtered ſolution with pure Nitrous Acid. The next day he obſerved

ſerved the bottom of the glaſs veſſel that contained it, covered with upright Cryſtals. The Lead in the mean time remained on the filtre.

205. These Cryſtals appeared in the form of ſmall ſhining Rhomboidal Flakes, had a metallic taſte, melted quickly before the blow-pipe on Charcoal, and were as quickly abſorbed by it. To Microcoſmic ſalt they imparted a graſs or olive green colour, in proportion to its quantity. They were ſoluble in warm water, and precipitable therefrom, with a BROWNISH RED colour, by Pruſſian Alkali. TIN put into this ſolution with a few drops of Marine Acid, was tinged BLUE, the Cryſtals alſo dropped into a ſolution of Tin, tinged it DEEP BLUE. Hence they conſiſted of MOLYBDENOUS ACID partially neutralized with Tartar.

207. On inſpecting what remained on the filter, it appeared to him that the Ore was not wholly decompoſed, and hence he repeated the experiment, melting 120 grains of the Ore with 600 of the Tartarin, and diſſolving it as before, he imperfectly ſaturated the filtered ſolution with Marine Acid, and obtained a white coagulated precipitate which contained both Molybdenous Acid and Calx of Lead; by adding more Marine Acid, this laſt was ſeparated in the form of acicular Cryſtals.

208. He then ſuper-ſaturated the remainder, with Marine Acid, and obtained again a thick precipitate, which edulcorated and dried, had the properties of Molybdenous Acid before mentioned, except that, until a few drops of Marine Acid

were

were added it was not perfectly ſoluble in diſtilled water.

209. The filtered liquor he then evaporated; it depoſited ſtill more of the Molybdenous Calx, in the form of a fine YELLOW heavy powder, which, collected edulcorated and dried became of a LEMON YELLOW.

210. What remained on the filter No. 207. was white Calx of Lead, mixed with Silex. It could not be reduced on Charcoal, on account of the Silex, but melted into a yellow glaſs. Hence he diſſolved the Calx in Nitrous Acid, and precipitated it by the Vitriolic into Vitriol of Lead. A ſmall portion of the Siliceous matter was originally in the Ore, but much alſo aroſe, from the corroſion of the crucible by the Alkali.

SPECIES VIII.

MOLYBDENOUS RED LEAD ORE.

BINDHEIM's examination of this Ore, contains rather a ſereis of experiments, then a connected analytic inveſtigation, and both his and MAQUART's are too prolix to be here inſerted.

211. However as MAQUART, from 142 grains of it, extracted 4,6 Cubic Inches of pure air, by pneumatic diſtillation, and as BINDHEIM found that ſix parts of the Ore mixed with one part of Charcoal inflamed with a crackling noiſe, the exiſtence of a large proportion of pure air is ſufficiently evinced.

212.

212. Again BINDHEIM having melted two drachms of the Ore with 12 of Nitre succeffively added in fix portions, obtained 63 grains of a yellowifh white Calx, which being diftilled over with 3 ounces of dilute Nitrous Acid, left a refiduum, that after edulcoration weighed 17 grains, part of this refiduum being diffolved in water, precipitated the Nitrous folutions of Silver, Mercury, Lead and Barytes, and this laft precipitate was foluble in water; part being melted with Microcofmic Salt, tinged it GREEN, and a piece of Tin inferted, with a few drops of Marine Acid into part of the folution became BLUE; Tincture of Galls precipitated the folution BROWNISH RED, and a part of the 17 grains being melted on Charcoal was immediately abforbed, hence the exiftence of the Molybdenous Acid in the Ore is fully proved.

Laftly if the Ore be diffolved in Aqua Regia, the Lead may be precipitated by the Vitriolic Acid. The other ingredients appear to be cafual.

215. IN THE DRY WAY, if 100 parts of the Ore be triturated with 200 of Tartarin, and the refiduum after washing off the Alkali be melted with 3 times its weight of black flux, 50 parts of Lead will be obtained. 4 BERL. BEOB. 297.

SPECIES.

SPECIES. IX.

Mineralized by Sulphur.

FIRST FAMILY.

Galena.

214. This Ore finely pulverized, ſtripped of all adventitious foreign matter and weighed, BERGMAN propoſes to analyſe either by dilute Nitrous or Marine Acid, in a boiling heat until all the Sulphur be ſeparated, whoſe purity when filtered of, waſhed and dried, he examines by Cauſtic fixed Alkali, combuſtion is however the mode generally uſed, as the Siliceous matter or Calx of Iron will remain.

215. The filtered ſolution he precipitates with aerated Soda, and after edulcoration, deſiccation and weighing, eſſays for Silver by Cauſtic Volalkali; if any be found, the loſs of weight, of the intire precipitate will indicate the weight of the aerated Silver; the remainder gives that of the aerated Lead. The quantity of Metal in the aerated Calces, will be ſeen in the annexed Tables.

216. If ANTIMONY be ſuſpected in the Ore, it may be calcined by concentrated Nitrous Acid, (or may be precipitated by Water).

217. If CALCAREOUS MATTER exiſts in the Ore, this ſhould firſt be extracted by Vinegar from the pulverized Ore.

218. If the solution be performed in Marine Acid, he advises the excess of Acid to be first removed by saturation with a fixed Alkali, until a precipitation begins to appear, and then both the Lead and Silver to be precipitated by a plate of Iron previously weighed, and lastly the Iron to be precipitated by Soda, the weight of Metallic Iron in the precipitate is indicated by the table, and this compared with the loss of weight in the plate, will give the quantity of Iron in the Ore.

219. If ANTIMONIAL CALX, be in the solution, it will be precipitated by Water.

WESTRUMB analysed an Ore of this sort in a simple manner.

220. To 600 grains of the Ore finely pulverized, he added six ounces of Water and three of Nitrous Acid and digested them in a very gentle heat.* After several hours he obtained a yellow deposit of Sulphur, weighing after edulcoration, &c. 95,5 grains, this burned without leaving any residuum,

221. The Nitrous solution he now evaporated to some degree, treated it with Marine Acid added to excess, and then evaporated it to half an ounce, collected the Muriated Lead, washed it with Alcohol, and when dry found it to weigh 605 grains.

222. The Alcohol washings he also gently evaporated in some measure, and then essayed for Copper or Iron with Volalkali, but none was found, Soda how-

* In one experiment, in which a somewhat greater heat was employed, and the Acid less dilute, the Sulphur was Oxygenated, and 6 grains of Vitriol of Lead formed.

ever

ever precipitated 1,5 grains of mild Calcareous Earth.

223. To ſeparate the Muriated Silver, if any were, he digeſted the Muriated Lead in Cauſtic Volalkali. The Muriated Lead thus loſt 3 grains taken up by the Alkali. The Alkali he evaporated to dryneſs; and boiled the reſiduum in a ſolution of mild Soda, and thus obtained $\frac{5}{8}$ of a grain of aerated Silver $= \frac{1}{2}$ grain of Silver.

224. Laſtly he mixed the muriated Lead which then weighed 602 grains with black flux well packed in a crucible covering it alſo therewith, and ſubjecting it to a melting head, obtained 498 grains of Lead.

225. IN THE DRY WAY. If the Ore be free from ſtony or other foreign matter, it is beſt eſſayed by mixing and melting it with $\frac{1}{3}$ of its weight of filings of Iron, or ſome what more of the Iron Scales of a Smith's Forge.

226. If it be leſs pure, it ſhould previouſly be gently roaſted, and then 100 parts of it mixed with 200 of black flux, 25 of filings of Iron, 25 of Sandiver, and heated at firſt gently and afterwards ſtrongly in a Smith's forge for 20 minutes.

The Iron is added to take up the Sulphur while the Alkali acts on the ſtony matter, the proportions are beſt regulated by the proportions of foreign matters found in the Ore by analyſis in the moiſt way.

227. If the Ore contains much Iron or Pyrites, then in addition to the black flux $\frac{1}{4}$ of Lime and $\frac{1}{4}$ of Fluor should be used.

228. To know whether it contains ZINC or ANTIMONY, it should first be gently roasted, then powdered Charcoal thrown on it while in fusion, the Zinc and Reguline Antimony will sublime in the form of white smoke.

229. Lead is separated FROM SILVER by Coppellation.

FROM IRON by bare fusion, as the Iron will float on the surface.

FROM COPPER by the addition of Sulphur which scorifies the Copper, it is discovered by treating Muriated Lead with Vol-alkali.

FROM TIN by Iron which unites to the Tin and leaves the Lead at bottom.

FROM ZINC by bare fusion in open air, still better by a blast of air.

SECTION VI.

MERCURIAL ORES.

SPECIES I. & II.

NATIVE MERCURY AND AMALGAMA.

230. To examine these Ores BERGMAN recommends solution in Nitrous Acid. The Gold (if any be) will remain untouched, but Silver or Bismuth (this last

laſt ſeldom occurs) will be co-diſſolved. The Biſmuth may be diſcovered and expelled by a copious affuſion of water; the Silver and alſo the Mercury in great meaſure will be precipitated by the ſolution of Common Salt, but water will take up the latter and leave the former. Much of the Muriated Mercury will alſo remain in the Nitrous ſolution.

231. HEYER firſt ſeparates the Mercury by diſtillation and then examines the reſiduum by Nitrous Acid.

SPECIES III.

HEPATIC MERCURIAL ORE.

232. The Hepatic Ore has not as yet been analyſed, SCOPOLI ſeems to have found Sulphur in ſome ſpecimens but not in others; ſuch ſpecimens as really conſiſt of Cinnabar, blended with Calces of Iron or Martial Clays ſhould be deemed a particular family of the Cinnabarine ſpecies.

Its analyſis may be attempted either as above, or as ſhall preſently be mentioned in treating of Cinnabar.

SPECIES IV.

VITRIOLATED AND MURIATED MERCURIAL ORE.

233 I join theſe, as they are found together, Mr. WOLFF who firſt diſcovered this ſpecies, determined the preſence of

the Vitriolic and Marine Acids by triturating 180 grains of the Ore with 120 of Tartarin, and as much water as rendered the mixture liquid; then dried it and expelled the Mercury by heat. Thus he obtained both Vitriolate and Muriated Tartarin, from the latter he expelled Marine Acid by the Vitriolic, and the former, in a ſolution of Nitrated Lime formed a ſelenite

234. BERGMAN determine the quantity of each of theſe Mercurial Salts in a given weight of the Ore by triturating and digeſting the Ore in Marine Acid, which expels the Vitriolic. Then diſſolving the whole in water, he ſeparated the Vitriolic by Muriated Bayrites, the weight of the Barſolenite thus formed determine the quantity of Vitriolic Acid, as this does that of the Mercury united to it, the proportions of each may be ſeen in the annexed Tables. Now the quantity of Vitriolated Mercury being ſubſtracted from the whole gives that of the Muriated Mercury.

SPECIES V.

NATIVE CINNABAR.

235. According to BERGMAN this Ore may be analyſed by Aqua Regia formed of 3 parts Nitrous and 1 Marine Acid, taken in 8 times the weight of the Ore and in the heat of ebullition. But HILDEBRAND has ſhewn that tho' the Ore is thus diſſolved, yet the Sulphur is not ſeparated.

To

To effect this feparation Aqua Regia formed of 3 parts Marine and 1 part of Nitrous Acid fhould be ufed.*

236. In the dry way, Ores are ufually effayed for Mercury by diftilling them in a ftrong heat, into a receiver half filled with Water. Cinnabar is de-compofed by diftilling it, with $\frac{1}{3}$ of its weight of filings of Iron, or even without any, if the Matrix be Calcareous.

237. The adulteration of Mercury may be perceived by its running with a tail on a Table, or ftill better by evaporating a quantity of it, on an Iron Spoon, or gently diftilling it from a Glafs retort. It is commonly adulterated with Lead, to which it may be fo well united by means of Bifmuth as to pafs thro' Leather. Bifmuth will even rife with it in diftillation. I generally purify it by Dr. Priestley's method, viz. By agitation with Water in a quart Glafs Phial, of which about $\frac{1}{4}$ is left empty, until the Water ceafes to be fullied. Thus the bafe Metals and femi-metals are calcined. From Gold or Silver it can be purified only by diftillation.

* Hildebrand on Mercury § 399. 400. 2 Chym. Ann. 1792. 167.

SECTION

SECTION VII.

ZINC ORES.

SPECIES I.

Mineralized by Oxygen.

FIRST FAMILY.

Loose and Friable.

238. Attempt their ſolution in dilute Vitriolic Acid, what remains undiſſolved is Silex, or Argill, or other ſtony Matter. Precipitate the Metallic Subſtances by a piece of Zinc previouſly weighed and boiling the ſolution: the Zinc by Pruſſian Alkali, the Argill by Cauſtic, the Calcareou Earth by mild Volalkali, or Soda. The quantity of Air may be diſcovered by the difference of weight before and after ſolution.

239. Earthy Ores often yield their Zinky contents to mild Volalkali by ſimple digeſtion.

SECOND FAMILY.

Compact.

This beſides Argill or other Earth, often contains a large proportion of Calx of Iron and ſometimes Lead, which renders its Analyſis more complex.

240.

240. Let the whole be repeatedly boiled in Nitrous Acid, and evaporated to dryneſs, taking each time twice the weight of the Ore. The Calx of Iron will thus become inſoluble or nearly ſo. Then digeſt the whole in dilute Nitrous Acid as long as any thing is taken up by it. The Calx of Iron, Silex and part of the Argill, will remain undiſſolved.

241. The ſolution ſhould be then treated with Cauſtic Volalkali, which added to exceſs will precipitate the Argill, Lead and any Iron that remains; leaving Calcareous Earth in the ſolution, and retaking the Zinc.

The Calcareous Earth if any, may then be precipitated by Vitriolic Ammoniac, and the Zinc by ſaturating the exceſs of Volalkali by any Acid.

242. The Calces of Iron, Argill and Silex No. 240, may be ſeparated as ſhewn in Vol. I. p. 466. 467. The Lead in No. 241. may be ſeparated from the Argill and Calx of Iron by ſolution in diſtilled Vinegar, or dilute Nitrous Acid, and precipitation by the Vitriolic Acid.

243. If it be only required to extract the Zinc, and no Lead is ſuſpected, the Ore may be treated as in No. 240, and the Zinc precipitated by mild Soda.

SPECIES

SPECIES II.

Blendes.

244. Mr. Bergman advises these Ores to be treated with dilute Nitrous Acid; if they contain no other Metal but Iron, this may be precipitated by a piece of Zinc, but if they contain other Metallic Substances, the Iron should be oxygenated; as in No. 240. and a new solution effected by distilled Vinegar or other appropriated Acid.

FIRST FAMILY.

Yellow.

245. Bergman dissolved this Ore in Marine Acid, which left only Sulphur and Silex undissolved. The Silver if any would remain also, and so would much of the Lead What the solution would contain of this latter might be precipitated by Vitriolic Acid.

SECOND FAMILY.

Red, or Reddish Brown.

246. The Ore of Salhberg* he first roasted, and thus found it to lose 13 per cent. 5 parts of which were mere Water. The remain-

* Cronst. §. 230.

ing

ing 87 he diſſolved in Nitrous Acid, oxygenating the Iron as before mentioned, and then re-diſſolving the reſiduum in a freſh portion of that Acid. The ſolution was found to contain no other Metal but Zinc, and this he precipitated with Pruſſian Alkali, afterwards by mild Volalkali he obtained Argill.

247. The reſiduum that eluded the Nitrous Acid, he treated with Vitriolic Acid diſtilled to dryneſs, Water extracted from this, all that was ſoluble.

248. The aqueous ſolution he treated with Pruſſian Alkali, which precipitated the Iron, what remained of the liquor taſted Aluminous, and on evaporation afforded ſome Alum mixed with Vitriolated Tartarin.

249. What evaded the Vitriolic Acid proved to be Siliceous.

THIRD FAMILY.

Black.

250. To Analyſe the black Ore of Dannemora. Mr. Bergman firſt torrefied 100 parts of it, and found it to loſe by that operation apparently no more than 25 per cent. But as all Metals gain weight by abſorbing Oxygen during calcination, it is plain it muſt really have loſt more, for as, what evaporated could not be weighed, the weight loſt could only be inferred, from the weight of the reſiduum after the torrefaction; now if this reſiduum had not abſorbed Oxygen it

it would weigh ſo much leſs, as the weight
of the Oxygen amounts to ; therefore to
find the real loſs, he added the weight
thus gained, to that which he had firſt
aſcribed to the volatilized matter, and
251. thus found it to be 37 per cent. To
find the weight of the Oxygen taken, he
was obliged to wait until the various Me-
tallic Calces contained in the Ore and
their proportions were diſcovered at the
end of the Analyſis, and then knowing
how much Oxygen 100 parts of each
Metal gain by calcination, he could
eaſily find how much the determinate
quantities of each found by the Analyſis,
had taken up. See the Tables.

252. By diſtilling a large quantity of the Ore, he found it to loſe 6 per cent. of Water, and about one grain of Arſenic.

253. The 75 grains of the calcined reſiduum he treated with boiling Marine Acid, as long as any thing appeared to be diſſolved. To the filtered ſolution concentrated by evaporation, he added Vitriolic Ammoniac, by which, and further evaporation, 6 parts of Vitriol of Lead were obtained.

254. The remaining liquor he evaporated to dryneſs, repeatedly added and abſtracted Nitrous Acid to Oxygenate the Iron, and heated finally the dried Maſs to ignition. And then with diluted Nitrous Acid rediſſolved the Zinky part. The un-diſſolved Calx of Iron weighed 13 grains, equivalent to about 9 of Metallic Iron.

255. The Nitrous ſolution of Zinc he then treated with Pruſſian Alkali, the precipitate he eſtimated at about 45 grains of Metallic Zinc.

Laſtly,

Laſtly, there remained about 4 grains of Siliceous Matter, which the Marine Acid had left untouched.

256. The bluiſh black Ore of BOVALLEN Mr. BERGMAN analyſed by a different proceſs. By torrefaction he found 100 parts of it APPARENTLY to loſe 17, moſt of theſe were Sulphur, but ſome moiſture was alſo detected.

257. The 83 parts that remained drenched with Oil of Vitriol were heated to dryneſs. This Maſs, treated with Water heated to ebullition, yielded all that was ſoluble, 6 parts only eluded its action, and theſe were proved to be Siliceous ſlightly contaminated with Calx of Iron.

258. In this ſolution a poliſhed Bar of Iron diſcovered Copper, the totality of which was extracted by boiling the ſolution with Iron. The Iron loſt 6 parts.

259. He then treated the ſolution with Pruſſian Alkali, the colour of the precipitate being white and blue indicated the preſence both of Zinc and Iron; to ſeparate theſe he evaporated the ſolution to dryneſs and calcined the dry maſs in an open crucible for a conſiderable time, and added and abſtracted Nitrous Acid from it ſeveral times to render the Iron inſoluble, at laſt this Acid diluted took up only the Calx of Zinc, and this he again precipitated by Pruſſian Alkali.

260. When we recollect that BERGMAN was the firſt Chymiſt who deviſed any thing like an exact method of analyſing Ores in the moiſt way, by which alone their contents can be truly found, and that

moſt of his proceſſes evince the moſt profound and extenſive knowledge of the complicated properties of their various ingredients, we muſt aſcribe to him a very high degree of merit, tho' ſome of theſe may have been ſince rendered more ſimple, and accurate. In the caſe before us it ſeems to me, that precipitation by Soda would anſwer better than by Pruſſite, as its action is much quicker and equally effectual, and introduces no foreign Matter into the precipitate. But he probably apprehended the preſence of ſome Earth, which induced him to prefer the Pruſſite; Volalkali however would precipitate both, but re-diſſolve the Calx of Zinc and leave the Argill, and thus ſhew if there was any of this laſt.

261. IN THE DRY WAY, the firſt Species, (and alſo the ſecond after torrefaction) is eſſayed by mixing it, well dried with $\frac{1}{2}$ its weight of dry Charcoal and diſtilling it in an earthen retort $\frac{3}{4}$ full, and to which a receiver is luted, in a ſtrong heat gradually increaſed for 5 or 6 hours. The Zinc in its Metallic form is found in the neck of the retort, and ſome flowers paſs into the receiver. CRONSTED found it often advantageous to let the Blendes effloreſce, and uſe only the ſubtle powder depoſited and ſeparated by waſhing.

262. According to SCHEFFER, all Minerals that contain Zinc, diſcover it when mixed with $\frac{1}{8}$ of their weight of Charcoal, and heated nearly to whiteneſs in a crucible, by the bluiſh Phoſphoric flame they then emit. SCHEFFER. §. 326. In effect

effect I have found many poor Calamines exhibit this appearance, but the Sulphurated Ores must first be torrefied, for while any Sulphur remains this experiment will not succeed.

263. ROERING melts Blendes with fixed Alkalis, and precipitates the Zinc dispersed through the flux, by adding filings of Iron. Another method of essaying these Ores, is by trying to convert, by their means Copper into Brass. The Blende, (if that be the Ore to be essayed) should be exceeding well roasted; to expel, not only the Sulphur, but also the Vitriolic Acid; hence the de-composed Ore well heated is the best.

The Copper should be beaten or rolled into thin plates and cut into small squares. Then to one part Copper take 1,5 Calamine or roasted Blende, well mixed and moistened, to prevent their separation, pack this mixture into a crucible by parcels, laying over each a thin stratum of pounded Charcoal, until the crucible is nearly full, then fill it up with the Charcoal, lute on a cover in which a hole is left to insert an Iron Rod. Let the crucible be gradually heated until a blue flame appears thro' the hole, then dip the Rod, if it meets with no resistance and falls to the bottom, the fusion is complete. The crucible may then be taken up, and after striking it gently, suffered to cool.

264. But in mere essays, it is sufficient to take 200 parts of the Zinc Ore mixed with 600 of black flux, and stratify the mixture with 200 parts of Copper, expose

pose it to a melting heat for 2 hours. The weight the Copper gains, will indicate the goodness of the Ore; the most that Copper can take is 89 per cent. Zinc Ores that contain less than 30 per cent. are useless, unless mixed with richer.*

265. According to GELLERT Zinc may be purified from Iron and Copper by Sulphur, covering the whole with Charcoal and melting the mixture, as the Sulphur will preferably unite with the Iron or Copper.

266. In the MOIST WAY Zinc is purified from most other Metals by inserting a piece of Zinc into the solution. However it does not precipitate either Nickel, Cobalt or Manganese nor even Iron until this is somewhat oxygenated, as it soon is, by exposure to the Air. The other substances are never found in it.

SECTION VIII.

ANTIMONIAL ORES.

SPECIES I.

NATIVE REGULUS.

267. The purity of this Ore may be essayed with strong Nitrous Acid, which calcines it slowly, but if the Regulus be pure, none will remain in solution, or if any

* Scheffer. §. 327. 329, G.

remain

remain in the folution, water will expel it. If it contains Arfenic this may be taken up by water, and the folution will precipitate that of Silver or Lead in Nitrous Acid, at leaft after 24 hours.

SPECIES II.

SULPHURATED ANTIMONIAL ORE.

268. To analyfe this Ore, BERGMAN propofes folution in Aqua Regia (compofed of 3 or 4 parts Marine and 1 part Nitrous Acid) which takes up the Reguline and leaves the Sulphureous part. The folution diluted with water difmiffes the Reguline part, and holds the Iron or Mercury (if any) in folution. If there be Lead, the Vitriolic Acid will feparate it, or the Aqueous folution duly concentrated will depofit it. If Silver be fufpected it will be found after the combuftion of the Sulphur.

269 IN THE DRY WAY, to obtain Antimony from its ftony Ores the ufual practice is to break the Ore into lumps of the fize of a nut, and cram them into a large crucible whofe bottom is perforated with holes of about $\frac{2}{10}$ of an inch in diameter, to this crucible a cover is exactly luted, then it is inferted and well luted to another half filled with water, which is kept as cool as poffible by furrounding it with afhes, fupported with ftones, while the crucible containing the Ore is fupported by a grate and gradually heated

heated to redneſs for 20 mintues, thus the Sulphurated Ore flows into the lower, and leaves the ſtony part behind.

270. To obtain the Regulus, heat 32 parts filings of Iron to redneſs, and project on them by degrees 100 parts of Antimony, when the whole is in fuſion throw on it by degrees 20 parts Nitre, and after a few minutes quiet fuſion, pour it into an Iron Cone previouſly heated and greaſed. It may alſo be obtained by melting 8 parts of the Ore mixed with 6 of Nitre and 3 of Crude Tartar gradually projected into a red hot crucible and fuſed.

271. To obtain pure Regulus, Margraaf melted ſome pounds of the Sulphurated Ore in a luted crucible, and thus ſcorified any metals it might contain. Of the Antimony thus purified, which lay at the bottom, he took 16 ounces which he calcined cautiouſly, firſt with a ſlow and afterwards with a ſtrong heat until it ceaſed to ſmell of Sulphur, and acquired a greyiſh white colour. Of this grey powder he took four ounces, mixed them with 6 Drachms Tartar and 3 of Charcoal, and kept them in fuſion in a well covered and luted crucible for one hour, and thus obtained a Regulus that weighed 1 ounce, 7 drachms and 20 grains.

272. The Regulus thus obtained he mixed with half its weight of deſiccated Soda, and covered the mixture with the other half, melted it in a well covered and luted crucible in a very ſtrong heat for half an hour,

hour, and thus obtained a Regulus, which weighed 1 ounce, 6 drachms and 7 grains, much whiter and more beautiful than the former. This he again treated in the same manner with 1,5 ounces of Soda, and obtained a Regulus weighing 1 ounce, 5 drachms, 6 grains. This Regulus was still purer than the foregoing. Repeating these fusions with equal weights of Soda, three times more, and an hour and a half each time, he at last obtained a Regulus so pure as to Amalgamate with Mercury with ease, very hard and in some degree malleable, the Scoria formed in the last fusion were transparent which indicated that they contained no Sulphur, and hence it is the obstinate adherence of the Sulphur that renders the purifica-
273. tion of this semi-metal so difficult. He also remarked that the Scoria afforded by treating the Regulus with Soda were GREEN, but, not those afforded by treating it with Tartarin. 2 MARGR. 423.

SPECIES III.

ARSENICO SULPHURATED ANTIMONIAL ORE.

274. When this Ore is not suspected to contain Silver, BERGMAN advises it to be treated with Aqua Regia, which leaving the Sulphur, will take up the Reguline and Arsenical part. To separate these he requires so much strong Nitrous Acid to be added, as will in a boiling heat calcine the former. The

filtered liquor again boiled with Nitrous Acid added, and evaporated to dryneſs, will leave the Arſenical Acid.

275. The Calx of Antimony may then be taken up by Marine Acid, and precipitated by Water, which will thus ſeparate it from any other metal mixed with it.

276. But if Silver be ſuſpected in the Ore it ſhould be digeſted with 6 times its weight of dilute Nitrous Acid, until the Regulus is calcined and the Silver taken up; Water will ſeparate whatever of the Reguline part the ſolution may contain, and a ſolution of Common Salt, will ſeparate the Silver.

277. Beſides, as Sulphurated Antimony is ſoluble in Cauſtic fixed Alkalis, and Silver not, this may be ſeparated by boiling the Ore in twice its weight of Cauſtic fixed Alkali.

278. IN THE DRY WAY, this Ore is freed both from Arſenic and Sulphur together by gradual torrefaction.

279. TO PURIFY REGULUS OF ANTIMONY from Lead or Iron, let it be melted with a little of the crude Ore; if then, when expoſed to the blow-pipe it is intirely Volatil it may be deemed free from thoſe metals.

280. According to WENZEL his MURIATICO VITRIOLIC ACID will take up Regulus of Antimony, and leave Lead, Regulus of Arſenic or Silver untouched, perhaps it may thus effect their ſeparation, if they chance to be united.

281. IRON MAY ALSO BE SEPARATED FROM, THE REGULUS, by dissolving both in Aqua Regia which will dissolve both, but Water will precipitate the Regulus leaving the Iron.

282. CALCES OF ANTIMONY are reduced by fusion with about $\frac{1}{5}$ of their weight of black flux, and thus I suppose the fourth species, and other Ores may be reduced.

SECTION IX.

ARSENICAL ORES.

SPECIES I AND II.

NATIVE ARSENIC AND ARSENICAL PYRITES.

283. These, according to BERGMAN, should be treated with 4 times their weight of Aqua Aegia formed of one part Nitrous and $1\frac{1}{2}$ or 2 Marine cid. If any Silver be in the Ore it will be precipitated from the beginning and the Marine Acid should be re-placed. If the solution be then evaporated to $\frac{1}{4}$ and Water added, the Arsenic will be precipitated, and this being filtered off, the Iron may be precipitated by Volalkali, &c.*

* Wenzel denies the precipitation of Arsenic from Aqua Regia by Water. Vewandich. 173. perhaps his Aqua Regia was different. See also 2 Bergm. 264.

284. IN THE DRY WAY, Arſenic is in great meaſure ſeparated from all Ores that contain it, by diſtilling the Ore groſſly pulverized, in a retort. The Arſenic riſes in the form o a white meal, or cryſtalized if the veſſels be ſmall and well luted. If the heat be increaſed Sulphur may alſo riſe, if the Ores contain any, and in this caſe Orpiment or Realgar or both will appear. If after the ſublimation, Greaſe or Charcoal be added to the Ore, more Arſenic may ſublime.

285. TO CONVERT THE WHITE CALX INTO a REGULUS, BERGMAN adviſes it to be mixed with three times its weight of black Flux and ſublimed from a crucible, to which another is luted, in a heat gradually increaſed to whiteneſs; others adviſe the Calx to be mixed with Oil, and ſublimed in a long necked Phial. This may anſwer for ſmall quantities. Perhaps a mixture of the Oil with the Calx, and black Flux would anſwer ſtill better. In either caſe a perforated plate of Copper ſhould lie betwixt both crucibles, to prevent the glare and heat of the lower, from affecting the upper.

SPECIES III.

ARGENTIFEROUS ARSENICAL PYRITES.

286. This is probably the Ore, which BERGMAN calls WHITE SILVER ORE, as according to him it contains beſides Arſenic, Silver alſo, and Copper.

To

To Analyſe it he directs it to be treated with 12 times its weight of dilute Nitrous Acid in a boiling heat; when clear, the ſolution to be decanted or filtered and the Silver precipitated by Copper, previouſly weighed, and the Copper by Soda or Iron.

287. The un-diſſolved part, which if properly ſeparated ſhould be white, is then to be repeatedly boiled in Marine Acid (or perhaps ſtill better in Aqua Regia) and when concentrated by evaporation, it will, on the addition of Water, depoſit the Arſenic. The Sulphur will then remain, and after combuſtion diſcover any heterogeneities it may have retained.*

288. IN THE DRY WAY, the Sulphur and Arſenic are expelled as uſual by torrefaction, and the Copper and Silver ſeparated by Cuppellation.

SPECIES IV.

NATIVE CALX OF ARSENIC.

289. This ſubſtance ſeldom occurs; when it does it may be taken up by 15 or 18 times its weight of boiling Water. Its ſolution turns Litmus red and Syrup of Violets green, and precipitates the Nitrous ſolutions of Silver and Mercury, but theſe precipitates are revived by mere heat, and the Arſenic diſperſed with its peculiar ſmell.

* Bergm 418. 3~3.

290. If the solution be impregnated with Hepatic Air, the Arſenic will be precipitated in the form of Orpiment or Realgar.

291. Strong Marine Acid will alſo diſſolve this Calx, and if it be concentrated by gentle evaporation Water will expell the Arſenic.

292. IN THE DRY WAY, it is diſcovered by its evaporation, in the form of a white Smoke on burning Coals or red hot Iron, with its peculiar ſmell. If laid on red hot Copper, it leaves a white or black ſtain, if Copper be held over it while ſubliming it concretes in the form of a white Powder; and if heated to whiteneſs between two plates of Copper, the Copper will be whitened.

29 . IT IS PURIFIED, by ſubliming it, from its own weight of Pot-aſh.

SPE IES V.

SULPHURATED ARSENIC.

294. To de-compoſe this Species BERGMAN employs Marine Acid, adding if neceſſary a little of the Nitrous, and long continued ebullition, until what remains untouched, becomes perfectly grey. The ſolution being then concentrated, will on the affuſion of Water, or at leaſt aided by Spirit of Wine diſmiſs the Arſenic.

295. Salited Arſenic may alſo be precipitated in its Metallic form by Zinc, with the aſſiſtance of Spirit of Wine.

296.

296. If there be any Iron in the Ore it will be taken up by the Marine Acid before the Arſenic and conſequently may be had apart.

297. IN THE DRY WAY, MACQUER recommends this Ore to be made into a paſte with liquid fixed Alkali then placed in a Matraſs; by a gradual heat the Arſenic will ſublime and the Sulphur be detained The Alkali ſhould equal the Ore in weight. Others adviſe mixing the Ore with Lead. Mercury will not effect a total ſeparation. Lead or Regulus of Antimony are ſaid to ſucceed better. Realgar containing leſs Sulphur, ſhould require leſs of theſe additions.

SECTION X.

BISMUTHIC ORES.

SPECIES I. & II.

NATIVE BISMUTH, AND BISMUTHIC OCHRE.

298. Theſe are eſſayed in the MOIST WAY, by ſolution in Nitrous Acid moderately diluted. This ſemi-metal is precipitable by Water; if the whole is not precipitated at firſt, the ſolution ſhould be concentrated by evaporation, then a ſecond affuſion of Water will precipitate the remainder. If Cobalt be mixed with the Ore the pale reddiſh appearance of the Ore will then betray it. If Silver, Marine

Marine Acid or Common Salt will detect it.

299. IN THE DRY WAY, the first species being already reduced, is barely melted with equal parts Borax and Glass in a crucible lined with Charcoal. The second species is reduced by the same mixture to which about $\frac{1}{4}$ its weight of Argol or Charcoal is added, or as the next.

SPECIES III.

300. IN THE MOIST WAY, this Ore is treated like the former.

IN THE DRY WAY, SCHÆFFER reduces this Ore after a gentle torrefaction, by mixing one part of it with 2 of black flux and 1 of Argol, melting them in a slightly covered crucible in a forge for 5 minutes.

Bismuth is generally separated from Cobaltic Ores by Eliquation.

SECTION. XI.

COBALTIC ORES.

SPECIES I.

ARSENICIFEROUS COBALT.

301. BERGMAN proposes analysing this Ore by solution in Aqua Regia, and by concentrating the solution by evaporation, thinks

thinks the Arſenic may be precipitated by water; however it ſeems better to expel it firſt as much as poſſible by torrefaction. He then evaporates the ſolution to dryneſs, and extracts the Cobaltic Calx by diſtilled Vinegar, and precipitates it by Soda.

302. The reſiduum ſhould be then treated with Cauſtic Volalkali, which will take up Nickel and leave the Iron.

303. According to RINMAN §. 163. If Ferriferous Cobalt be diſſolved in Nitrous Acid or Aqua Regia, Regulus of Antimony inſerted in the ſolution will be diſſolved, but cauſe no precipitation, but on adding Water both it and the Cobalt will be expelled, leaving the Iron in the ſolution. The precipitate treated with Volalkali, or diſtilled Vinegar, will yield to them the Cobalt leaving the Antimonial Calx, which is but very ſlightly ſoluble in the laſt mentioned menſtruum.*

304. He alſo adds that Iron may be precipitated from a Cobaltic ſolution in Aqua Regia or Marine Acid by Zinc. If the filtered ſolution be then precipitated by Soda, the Calx of Zinc may be expelled by heating the precipitate mixed with Charcoal to whiteneſs, as the Zinc when reduced flies off. This however is ſingular as Zinc is known not to precipitate Iron when ſingle, until the Iron is oxygenated. This effect does not take place ſo exactly when Nitrous Acid is the ſolvent of Cobalt.

* Monnet diſſolution des Metaux. 258. 266.

Ibid: and 4 BERGM. 377. If the Ore contains Bismuth, this should be at first separated by Water, and the remainder by a few drops of Tartarin and agitation.

305. According to GERHARD, the Arsenic should first be expelled by torrefaction, the Ore then dissolved in Nitrous Acid, and the Iron oxygenated by continued ebullition. He then treats the solution with a fixed Alkali, which precipitates the Iron first of a yellow colour, and next the Cobalt Violet, when this last begins to appear he pours off the solution, and then by Soda, &c. obtains the Cobalt unmixed. As he takes no notice of Nickel, I suppose there was none in the specimens he examined.

RICHTER frees Cobalt from Iron by solution in Nitrous Acid, precipitating by Soda, and re-dissolving the precipitate in Vinegar. If the acetous solution still contains Iron by precipitating again by Soda and treating it again with Vinegar, repeating this precipitation and solution twice or oftner, at last it will be found perfectly pure.

306. KLAPROTH previous to his Analysis of the Cornish Ore, explored its contents in a general way by Preliminary experiments.*

1. He gradually dissolved half an ounce of the pulverized Ore in Aqua Regia, formed of equal parts Nitrous and Marine Acids, all was taken up to 1,5 grains, which on burning Coals gave a smell at first Sulphureous, and at last Arsenical.

* 1 Berl. Beob. 182

307.

307. The filtered ſolution, which was of a browniſh colour, he SEMI-SATURATED with Tartarin which produced a whitiſh and Ochre yellow precipitate weighing when dry 5 drachms and 15 grains. It conſiſted of Iron and Arſenic, for being mixed with finely powdered Charcoal and heated to redneſs, the Arſenic exhaled in the form of a white ſmoke and left the Iron behind. He then fully ſaturated the ſolution with Tartarin, it afforded a greyiſh red precipitate which was the Calx of Cobalt. This edulcorated and dried weighed 1 drachm and 15 grains. Thus the exiſtence of Iron, Arſenic and Cobalt in this Ore was proved, but the Sulphur was only perceptible by the ſmell and conſequently in an inpretiable quantity.

308. 2. One ounce of the pulverized Ore, calcined until it no longer ſmelled of Arſenic became dark brown, and loſt exactly $\frac{1}{3}$ of its weight, but as at the ſame time it gained weight, it is plain it contained above $\frac{1}{3}$ of Volatil matter, and this muſt have been moſtly Arſenic, as it contained ſo little Sulphur. The reſiduum then, or 320 grains of Cobaltic Calx mixed with two ounces of black flux, one drachm of Roſin, and covered with common Salt, he melted in a roomy crucible and obtained a Regulus weighing 158,5 grains and 3,5 grains of Biſmuth; (as theſe do not mix in fuſion.) The Cobaltic Regulus thus obtained was Magnetic when pulverized,

verized, (as he had not in this caſe ſeparated the Iron,) but not in lumps.

309. This Regulus he pulverized and gradually diſſolved in Nitrous Acid, digeſted it for ſome time, diluted and filtered it, thus he obtained Calx of Iron on the filter. But ſtill the ſolution retained more of it, for it was of a browniſh colour, and being mixed with a little common Salt, gave a GREEN ſympathetic Ink. He
310. diluted it then ſtill more, and gradually dropped into it a ſolution of Tartarin, which precipitated a ſlimy Ochrous matter, as ſoon as a VIOLET precipitate appeared he ceaſed adding more of the Alkali until the ſlimy matter was filtered off. The ſolution now at laſt became ROSY RED and with common Salt gave an AZURE BLUE ſympathetic Ink. This ſolution he precipitated by Tartarin and thus obtained 70 grains of dried Calx, which when in powder was of a VIOLET BLUE colour, and 2 grains of it imparted a beautiful blue to 480 of Glaſs Frit.

311. When the Ore beſides Arſenic and Iron contains alſo Nickel, it ſhould after torrefaction be diſſolved in Nitrous Acid and boiled, by which it will be freed from part of its Iron as we have juſt ſeen, then precipitated by a fixed Alkali, and the precipitate waſhed and dried, treated with diſtilled Vinegar which will leave moſt of the Iron and take up the Calx of Cobalt before it acts on that of Nickel. I ſuſpect alſo that a ſolution of Sal Ammoniac would take up the Nickeline part and leave the Cobaltic.

312

312. Some Cobaltic Ores contain according to GERHARD, Lead, Tin and Bifmuth. In the MOIST WAY thefe may be feparated by folution in Nitrous Acid, which leaves the Tin calcined, as already feen; Water will feparate the Bifmuth, and the Lead may be precipitated by Vitriolic Acid, and concentrated. But in the dry way GERHARD feparates them by fufion with three parts Tartar and 1 of Nitre, the Lead, Tin and Bifmuth are found at the bottom, and the Cobaltic Regulus at top, which may be feparated by a knife or sciffars. However he owns the feparation is not quite perfect. Mem. Berl. 1779. 14.

313. GERHARD alfo mentions his having feparated Cobalt from Nickel by gradually dropping a faturate folution of the Cobalt Ore, into Spirit of Sal-Ammoniac, a precipitation took place but the precipitate was inftantly re-diffolved, and the liquor affumed a garnet colour. When the Volalkali was faturated, he filtered it and a grey powder remained on the filter, which proved to be Nickel, he then precipitated the filtered liquor by an Acid; it depofited a peach red precipitate which proved to be Cobaltic Calx. Mem. Berl. 1779. 18.

I muft own I do not well underftand this experiment. The Alkali he fays was faturated by the folution, it muft have been fo by the Nitrous Acid contained in that folution, why then faturate it over again by another Acid? was there not an excefs

excefs of Volalkali? or did the neutralized Alkali hold the Cobalt in folution and not the Nickel? GMELIN repeated this experiment with MILD Volalkali without fuccefs.* It fhould then be repeated with Cauftic Volalkali.

314. IN THE DRY WAY, Cobalt and Nickel are feparated imperfectly by a ftrong and tedious calcination, the Nickel forming greenifh vegetations which are picked out. But Iron and Cobalt cannot be feparated thus, but only by the mixed modes already mentioned.

315. If the Cobaltic part much exceed the Nickeline, they may in great meafure be feparated by fufion with Liver of Sulphur, which fparingly ufed takes up the Cobalt and leaves the Nickel.

316. NOTE. The green colour of a folution of Cobalt is not always a proof that it contains Nickel, for the fmoking Spirit of Salt affumes with it fometimes a green and fometimes a blue colour as KLAPROTH obferved, but thefe colours vanifh, and the red appears on dilution with Water, or addition of Vitriolic or Nitrous Acids.†

* 1 Chym. Ann. 1794 6.

† 1 Berl. Beob. 185.

SPECIES

SPECIES II.

Sulphurated Cobaltic Ore.

317. This after the expulſion of the Sulphur by torrefaction or its depoſition after ſolution in Nitrous Acid, is treated like the foregoing.

SPECIES III.

Cobaltic Calxs.

318. Theſe beſides Cobalt often contain Silver, Copper and Iron. Diſtilled Vinegar will take up the Cobaltic and Cupreous Calces, and then Nitrous Acid the Silver, which may be precipitated by ſolution of common Salt. Or elſe diſſolve the whole in Nitrous Acid, by digeſtion and ſubſequent filtration moſt of the Iron will be ſeparated,—The Silver alſo by common Salt, or a plate of Copper if there be any already in the ſolution. Iron will then expel the Copper.—If then the liquor be evaporated to dryneſs, diſtilled Vinegar will take up the Cobaltic Calx, leaving the Iron and Argill.—Or Cauſtic Volalkali will take up the Cobalt leaving the Iron and Earths if any.—An Acid will ſeparate the Cobalt from the Alkali, or they may be ſeparated by diſtilling off the Alkali.

319. The black Calx is ſaid to be ſometimes difficultly ſoluble in Nitrous Acid. I have not found it ſo, but in ſuch caſe Marine Acid or Aqua Regia may be uſed. If theſe Ores afford Red vapours with Nitrous Acid they may be preſumed to be rather in a comminuted than a calcined ſtate.

320. BLUE CLAYS holding Cobalt and Copper, BERGMAN treats as juſt mentioned, ſeparating the Copper by a plate of Iron, evaporating the ſolution to dryneſs, and taking up the Cobalt by diſtilled Vinegar. Zinc alſo will precipitate Copper but not Cobalt.

321. Sometimes theſe Calces are mixed with ſo much Iron that the ſolution in Nitrous Acid or Aqua Regia ſcarcely diſcovers any ſign of Cobalt, in ſuch caſe it ſhould be farther diluted and cautiouſly treated with Cauſtic Volalkali, which will precipitate the Iron, after which the ſolution will aſſume the red colour peculiar to Cobalt.

SPECIES IV.

322. This BERGMAN has ſhewn to contain the Arſenical Acid, and it being inſoluble in Water, he treated it with Vitriolic Acid, which expelling the Arſenical, united with the Cobalt. Then (after I ſuppoſe reducing this compound to a dry ſtate,) by highly rectified Spirit of Wine he took up the Arſenical Acid; Vitriol of Cobalt being inſoluble in Alcohol.

323. IN THE DRY WAY, I suppose it might be decompoſed by deoxygenating the Arſenical Acid, mixing the compound with Pitch or Wax and burning it, then expelling what Arſenical Calx might remain, by torrefaction.

324. In general, COBALTIC ORES ARE ESSAYED in the manner mentioned in the 23d. Chapter

SCHÆFFER uſes the ſame proceſs, only he puts in the Tartarin firſt, then the Sand, and over all the pulverized Ore. The Calciform Ores need only to be dried, not roaſted, as they contain no Arſenic; ſome may bear waſhing, tho' I believe this is not often done. A very good Ore may give a good tinge to 12 times its weight of Sand.

325. TO PREVENT DECEPTION, it ſhould be remembered that ſome other Metallic Subſtances in particular circumſtances and with certain fluxes impart a blue tinge to Siliceous Subſtances. Thus 3 grains of pure Calx of Nickel with 60 of Tartarin and 80 Silex, gave a VIOLET BLUE Glaſs per KLAPR. 2 BERL. BEOB. 0. And according to GERHARD one part Baſalt, 0 Silex and 1 of fixed Alkali melt into a BLUE Glaſs. Mem. Berl. 1779. 19. Glaſs alſo (if the Alkali predominates in it) aſſumes a VIOLET tinge from Calx of Manganeſe, otherwiſe a Red. So alſo 10 grains of the yellow Tungſtenitic Calx, 120 of the Vitriform Phoſphoric Acid, and 60 of Siliceous Sand, afford a SAPPHIRE BLUE Glaſs, tho' Borax be not altered

 by

by this Calx. per KLAPROTH, 1 BERL. BEOB. 191.

326. TO OBTAIN REGULUS OF COBALT, the Ore well roasted, (or washed if earthy) should be carefully mixed with two parts of a flux formed of equal parts black flux and Argol, and melted in a crucible slightly covered. KLAPROTH, to $\frac{1}{3}$ of an ounce of roasted Ore, added, 2 ounces of black flux and 1 drachm of Rosin, thoroughly mixing the whole, covering with common Salt and obtained $3\frac{1}{3}$ per cent. (of the crude or roasted Ore) of Regulus.—According to SCHÆFFER the best Ores contain from 50 to 60 per cent.

327. TO OBTAIN PURE REGULUS OF COBALT, the Regulus obtained as just mentioned should be purified from Iron, or Iron and Nickel by some of the methods mentioned in treating of the first species.* (The Regulus obtained from the blue Calciform Ores is commonly the purest,) and then melted with black flux and Rosin.

SECTION XII.

ORES OF NICKEL.

SPECIES I.

NATIVE NICKEL ALLOYED WITH IRON.

328. It is soluble in Nitrous Acid. By this solution much of the Iron is depo-

* See particularly No. 309. 310. 311.

sited

fited. Its fubfequent treatment will be feen in No. 336.

SPECIES II.

Nickel Ochre.

329. This being a mixture of Arfenicated Nickel and Vitriol of Nickel, thefe fhould be feparated by elixiviation, this laft being foluble and the former not. How Vitriol of Nickel fhould be treated will be feen No. 352. How Arfenicated Nickel, we fhall next fhew.

SPECIES III.

Arsenicated Nickel.

330. Gmelin treated 120 grains of this Ore with 3 ounces of ftrong Marine Acid in a heat fomewhat inferior to that of boiling, and found it all diffolved to 3 grains, which appeared to be Barofelenite adhering or mixed with the Ore.*

The diluted folution he filtered adding fo much water as to make the whole 7 ounces. To 4 ounces of this he added, mild Volalkali, a precipitate at firft appeared, but foon vanifhed; however the whole was not diffolved before filtration; he then filtered it, and to the refiduum on the filter continued to add more Alkali until all was diffolved to

* 1 Chym Ann 1794. 2

one grain, what paſſed laſt was of a purple colour.

331. The blue Alkaline ſolution he diſti led for the moſt part, and obtained a greeniſh depoſit weighing o grains. This he treated PER SE in a ſtrong heat, but could not melt it. But by the addition of Borax and Charcoal, obtained very brittle reddiſh white metallic globules, which were not magnetic.—perhaps not perfectly melted.—Diſtiling off the remainder of the Volalkali he obtained a reſiduum weighing 223 grains, which was nearly of the ſame nature as the foregoing.

SPECIES IV.

Sulphurated Nickel.

332. To examine this Ore in the liquid way, it may be diſſolved in Nitrous Acid, and much at leaſt of the Sulphur depoſited, and perhaps part of the Arſenic ſeparated; by concentrating the ſolution and adding water much may alſo be ſeparated.

333. But the uſual method is to expel as much as poſſible of both by long continued torrefaction. The Ore then loſes from $\frac{1}{3}$ to $\frac{1}{4}$ its weight. And as I believe much of the Sulphur is acidified, it then becomes GREEN and ſo much

334 the greener as it is richer.—On the Ore in this ſtate no analytic experiments, that I know of, have been made. It is then

then mixed with two or three times its weight of black flux covered with common Salt, and melted in a forge by a violent heat continued from half to $\frac{3}{4}$ of an hour. The Regulus is generally from $\frac{1}{10}$ to $\frac{1}{2}$ of the crude Ore. 2 BERGM. 234. This is called CRONSTED'S Regulus.

335. This Regulus BERGMAN dissolved in Nitrous Acid, and evaporating the solution, obtained crystalized Nitrated Nickel; thus, much of the Iron and probably also much of the Arsenic were got rid of, the Crystals he calcined, and during calcination sprinkled them over with powdered Charcoal, by which means much (perhaps all) the Arsenic was Vo-

336. latilized. This Calx reduced (probably with black flux) gave a grey semi-ductil Regulus, but when this also was dissolved in Nitrous Acid and precipitated by a fixed Alkali, the precipitate reduced gave a brittle Regulus 2 BERGM 253. Which might proceed from imperfect fusion or absorbtion of Carbon from the flux, for this second Regulus, treated as the former gave a third that was semi-ductil.

337. Again having dissolved another portion of the Regulus of CRONSTED in Nitrous Acid, and precipitated the solution by a fixed Alkali, after edulcoration and desiccation he exposed 487 grains of it to Volalkali added to excess; after 24 hours he found the whole dissolved except 50 grains, consequently 437 remained in the solution; yet this solution filtered and evaporated

rated to dryness left only 282 grains.*
These reduced afforded a Regulus, white
Semi-ductil and Magnetic, weighing 35
grains and its Specific Gravity 7,000, the
Scoria were of a bay colour, gave a
Hyacinth red to Borax and contained as
much Calx of Nickel as afforded a Regulus
of 30 grains, which being mixed with the
former was infusible by the blow-pipe
even with Borax. Yet, calcined with
powdered Charcoal, smelled neither of
Sulphur or Arsenic, and when reduced,
tinged the flux Hyacinth red, and was
soluble in Nitrous Acid, to which it gave
338. a beautiful green colour. This I take
to have been pure Reguline Nickel.

339. The residuum of 50 grains, No. 337, which the Volalkali left un-dissolved, he also reduced, about 13 grains of a bright whitish scaly brittle Regulus were produced, its Specific Gravity 9,333. This BERGMAN seems to have considered as the purest Regulus of Nickel, for p. 267 he says its Specific Gravity is not lower than 9,000 at the least, and yet he owns its Scoria were obscurely BLUE at bottom, where in contact with the Regulus, and reddish brown at top

That it gave at first a blue, and then a Hyacinth colour to Borax.—That it was easily fusible, and yet p. 28 ; he asserts that Nickel is so much the more refractory as it is purer.—That it continued

* Here then is a loss of 155 grains, and supposing the 437 to proceed from 323 of Regulus of Nickel (which is Bergman's rate) and supposing the Calx here revived, that there would be a loss of 41 grains unaccounted for.

Sulphur

Sulphur.—And laſtly that Nickel is intirely ſoluble in Volalkali, and yet this Regulus proceeded from 50 grains that were inſoluble in that menſtruum.

340. Hence I am inclined to think that this Regulus was much more impure than the former. The blue tint communicated to the flux is an ambiguous ſign of Cobalt as a ſmall proportion of Nickel or Manganeſe might impart it, and it is remarkable that BERGMAN never ſuſpected the preſence of this ſubſtance.

341. The variations of Specific Gravity often remarked by BERGMAN might proceed from the more or leſs perfect fuſion of this refractory Metal, from the variable quantity of Carbon it might have imbibed in fuſion, from the variable quantity of Sulphur retained, and the more or leſs intimate union it might have contracted with Manganeſe or Iron.

342. IN THE DRY WAY, BERGMAN employed all the expedients which the profoundeſt knowledge of the Metallurgic art could ſuggeſt to purify this Semi-Metal; theſe were Torrefaction, Sulphurization, Hepatization, Calcination by Nitre, and Deferrification by Sal-Ammoniac. His ſubject was CRONSTED's Regulus.

343. 1. By Torrefaction he expelled much of the Sulphur and Arſenic ſtill inherent in that Regulus, much of the Iron and (as he thought) of the Cobalt remained in the Scoria. After four ſimilar torrefactions long continued and alternate reductions, he found the Specific Gravity of

of the Regulus only 7,088. Hence it is plain that the Specific Gravity of the impurest Regulus of Nickel is higher than that of a purer, for the Specific Gravity of CRONSTED's Regulus was 7,421.—Yet it still contained Arsenic, which he expelled by torrefying the comminuted Regulus with pulverized Charcoal.—If this had been done sooner, it appears that the Regulus would have been much sooner purified, for after this Calx was reduced, the Regulus it afforded no longer formed green vegetations when calcined, nor exhaled an Arsenical smell, and the Regulus afforded by this Calx imparted an exceeding pure green colour to Nitrous Acid; it left, it is true a black insoluble residuum which appears to me to be nothing more than a kind of Plumbago resulting from the Coal, accordingly it whitened and evaporated on burning Coals with scarce any smell of Arsenic. This Regulus and another resulting from the reduction of the Calces of that last mentioned, were Magnetic, hence he judged them to be still impure, but there is much reason to suspect that Iron is not the only substance capable of Magnetism.—Upon the whole this Regulus which was whitish and semi-ductil was in my opinion as pure as Iron and other metals commonly are.

344. In this way therefore Nickel after two or three torrefactions with Charcoal and subsequent reductions, may always be obtained pure.—when it is so, it does

does not vegetate when calcined. and its Calx is not green but brownish red, and the ſcoria attending its Calcination are of the ſame colour —If neceſſary its farther purification may be attempted in the moiſt way by Volalkali as in No 337.

344. 2. His object in adding Sulphur to the Regulus was, to free the ferruginous part from the Sulphur, thinking it had a greater affinity to Nickel than to Iron. The contrary however ſeems to me to have taken place, the Nickel and Iron ſeem to have combined more cloſely, which circumſtance together with the thorough expulſion of the Arſenic, rendered the Specific Gravity of the compound Regulus higher.

345. 3. As Cobalt unites more eaſily with Liver of Sulphur than with Nickel, he reſorted to this ſubſtance as proper to promote their ſeparation, and in effect found that by projecting Nitre on the Hepar that kept them both as he imagined in fuſion, and thus deſtroying that portion of it that kept the Nickel in ſolution, he found he ſays the Nickel freer from Cobalt. The proof of this however he has not given

346. 4. By Calcination with Nitre, he expected that the Cobalt, Iron, Sulphur and Arſenic would be ſeparated from the Nickel, as this ſeemed more difficultly oxygenated than the former ſubſtances, but it does not appear to have expelled the Cobalt, but only the Sulphur and Arſenic; the only reaſon he had for thinking the Cobalt alſo calcined, was

 the

the BLUE colour ſtruck on the ſides of the crucible; but this might proceed from the power which Tartarin has of receiving this colour from a ſmall proportion of Calx of Nickel, as KLAPROTH has ſhewn. The Iron in this experiment ſeems after the expulſion of the Arſenic to have united more intimately with the Nickel.

348. 5. Sublimation of Sal Ammoniac from the calcined Maſs, was found inſufficient
349. to ſeparate the Iron. BERGMAN ſeems inclined to think that Nickel may be ſome PECULIAR MODIFICATION OF IRON, this however muſt mean that it contains ſome other matter beſides Iron, otherwiſe this word is without a meaning; all the other known modifications of Iron proceed from its containing Siderite, Carbon, Oxygen, &c.

350. TO OBTAIN THE PUREST REGULUS OF NICKEL, KLAPROTH employed the following proceſs —— 1. The Ore broken into ſmall bits is torrefied until it no longer ſmells of Sulphur or Arſenic, and forms green vegetations; this Calx is reduced by two parts black flux, and a yellowiſh white brittle and fuſible Regulus is obtained.

351. 2. This Regulus is again broken and calcined, and then digeſted with its weight of Oil of Vitriol, and diſtilled to dryneſs. The dry maſs is diſſolved in Water and filtered, this ſolution depoſits Cryſtals of Arſenic, and finally affords dark green Rhomboidal Cryſtals of Vitriol of Nickel.

352.

352. 3. The Vitriol of Nickel is re-diſſolved in Water and precipitated by Tartarin, edulcorated dried and re-diſſolved in Volalkali, the blue ſolution leaves a Reſiduum which is filtered off; the filtered liquor is then ſaturated with Nitrous Acid, and the Nickel precipitated in the form of a greyiſh green powder by Tartarin; from this Calx the pureſt Regulus is obtained. 2 Berl. Beob. 34.

SECTION XIII.

ORES OF MANGANESE.

SPECIES I.

Native Manganese.

353. An Ore ſuſpected to be of this ſort may be examined by eſſaying its ſolubility in Marine Acid, its precipitability therefrom in the form of a white Calx by aerated Soda, the colour this Calx aſſumes by expoſure to the air or heat, the deportment of this Calx, if blackened, with the Nitrous Acid, with or without the addition of Sugar.

SPECIES II. and III.

Grey, Black, Brown, White and Red Calces of Manganese.

354. Theſe are generally mixed with more or leſs Iron, mild Calcareous Earth or Barolite.

355. To analyſe theſe Ores, BERGMAN adviſes ſolution in any of the Mineral Acids, adding Sugar from time to time. The WHITE Ores do not require this addition, nor do the RED often, and always leſs than the others. With reſpect to the GREY, BLACK and BROWN, the quantity of Sugar is proportioned to the purity of the Ore, that is the proportion of Manganeſe it contains, and of the oxygenation of the Acid. BINDHEIM to diſſolve the black Manganeſe of ILEFELD, which is of the pureſt kind, employed above 5 times its weight of Nitrous Acid, and $\frac{1}{4}$ of its weight of Sugar.
356. GADOLIN to diſſolve 40 grains of Calx of Manganeſe uſed 9 times its weight of Nitrous Acid whoſe Specific Gravity was 1,283 and 8 times its weight of Water in a very gentle heat only laying the retort near the fire, and adding only 9 or 10 grains of Sugar. The kind of Sugar employed may alſo deſerve conſideration. The Marine Acid requires leaſt Sugar, and ſeems beſt adapted for theſe experiments; a gentle heat ſhould be employed, Sugar being added the formation of the oxymuriatic Acid is prevented. Its production is a ſure ſign of the preſence of Manganeſe.

357. TO SEPARATE IRON FROM MANGANESE, we have already given ſome methods, No. 122, &c. To which we ſhall here add that of Meſſrs. ELHUYART, which is grounded on the greater affinity of the Marine Acid to the Calx of Manganeſe than to that of Iron—

They

They diſſolved the Ore in Marine Acid and evaporated the ſolution ſlightly, then ſaturated the exceſs of Acid with fixed Alkali until the liquor began to grow turbid, then made it boil for a quarter of an hour; in proportion as it heated it depoſited a plentiful precipitate, which being filtered off proved to be Iron; the filtered liquor was clear and colourleſs, containing only Manganeſe, which they precipitated by a mild fixed Alkali.—WESTRUMB's method may be ſeen No. 362. It is tedious.

358. According to HERMSTAD the ſolution of Tartarized Tartarin does not precipitate Iron from the Marine Acid, tho' it does Manganeſe from that Acid Hence he concludes it would ſeparate the later from the former metal. 2 Chym. Ann. 179.. 315.

359. According to RICHTER, Manganeſe is perfectly ſeparated from Iron by treating its ſolution in Vitriolic Acid with that of Tartarized Tartarin in a gentle heat, if both ſolutions be ſufficiently concentrated, the mixture will immediately become turbid, the evaporation ſhould be continued until the Tartar Vitriolate begins to Cryſtalize. The clear liquor poured off, the reſiduum ſparingly waſhed to carry off the Tartarized Iron, and then dried and ignited to diſperſe the Tartarous Acid, exhibits the Calx of Manganeſe perfectly pure.—The Water of Elutriation joined to the liquor poured off, may alſo be farther evaporated

to

to find whether it will ſtill depoſit any precipitate.

360. As the Bluish Black Ore of Mangaueſe had been taken for Cobalt, by an eminent Mineralogiſt, chiefly by reaſon of ſome Chymical experiments imperfectly conſidered, Westrumb ſubjected a mixture of 25 grains of an Ore of this ſort with 400 of Tartarin, to a ſtrong heat in a crucible, and thus obtained a bluiſh black powder and a compact bluiſh ſlag which thrown in Water, became firſt Green, then Blue and laſtly Red. And thus was evidently proved to be Manganeſe.

361. He alſo tried 50 grains of it with Aqua Regia, to ſee whether it would give a ſympathetic Ink as it was ſaid to do; 10 grains of a white powder remained undiſſolved, the ſolution was at firſt yellowish Red, and during digeſtion and evaporation became ſtill Redder and at laſt of an Amethyſtine colour. Letters then written with it were green while warm, and did not vaniſh on cooling but became yellowiſh, and when again warmed Brown.—He then proceeded to its Analyſis.

362. Treating 50 grains of it with Marine Acid in a gentle heat, he obſerved it to yield oxymuriatic Gas, 15 grains remained undiſſolved which appeared to be Siliceous.—The ſolution was green but by continued ebullition become yellow, and the addition of Sugar did not render it colourleſs, hence it appeared to contain Iron and this indication was confirmed by obſerving

ferving that Pruffite precipitated it BLUE and a mild Alkali WHITE. But this white precipitate when dried and expofed to the air became RED which pure Manganefe would not do.

363. 2. To find the proportion of thefe Ingredients, to 200 grains of the Ore he applied a fufficiency of MEPHITO-NITROUS Acid * 52 grains remained undiffolved, which being heated for fome time to whitenefs, were reduced to 40,5. Thefe treated with frefh Nitrous Acid left about 19,7 undiffolved.

364. He then returned to the Metallic folution; by inferting a plate of Iron into it, he found it contained a very minute proportion of Copper, and trying it with concentrated Vitriolic Acid difcovered neither Calx nor Barytes.—The feparation of Iron and Manganefe he found imperfectly effected, either by the acetous Acid, or Oxygenation and folution in Nitrous Acid with Sugar.

365. The application of Pruffite fucceeded better; to the folution diluted with 20 times its weight of Water, he added fome Nitrous Acid, and into this dilute folution he gradually inferted 120 grains of cryftalized and finely pulverized Pruffite, as long as a BLUE precipitate enfued, and until a WHITE precipitate appeared, he then agitated the liquor and digefted it for 8 days, and then left it in a cool place to fettle. The fuperna-

* Heretofore called Phlogifticated Nitrous Acid.

tent

tent liquor being at laſt clear he poured it off, edulcorated and dried the precipitate which then weighed 93 grains and after ignition only 53. Now as he knew his Pruſſite to contain 15 per cent. of Iron, he deducted 22,5 from the 53. there remained 30,5 as the ferruginous contents of 200 grains of the Ore.

366. The decanted liquor he then precipitated with mild Soda; the precipitate was white and weighed when dry 185 grains; as he ſuſpected it to contain Argill, he eſſayed it with diſtilled Vinegar, but found the whole diſſolved: this ſolution he again precipitated with Soda and heating the precipitate to redneſs, found it to become perfectly black, it then weighed 90 grains.

367. GADOLIN diſſolved 240 grains of Calx of Manganeſe in 1440 of Marine Acid of the Specific Gravity 1,175 in a temperate heat; 45 grains which appeared to be ferruginous Sand remained undiſſolved.

368. Into the diluted and filtered ſolution he dropped dilute Vitriolic Acid, which produced a white precipitate conſiſting of Barſolenite, it weighed when dried about 12,5 grains.——The Barſolenite being ſeparated by filtration, he again treated the filtered and ſtill farther diluted ſolution with Tartarin, this produced a precipitate which was re-diſſolved by the exceſs of Acid with efferveſcence. But the addition of *more* Alkali cauſed a ſecond precipitation which, neither efferveſced nor re-diſſolved. The liquor being

ing then ſtrongly digeſted was filtered off, and the precipitates edulcorated and dried in a temperate heat weighed 297,6 grains.

370. This dried precipitate being treated with Vitriolic Acid diluted with 3 times its weight of Water, efferveſced, but formed only a turbid ſolution; the ſolution gradually depoſited a white Matter which was inſoluble in above 100 times its weight of Water, became milky when re-diſſolved in dilute Vitriolic Acid, and from this ſolution Pruſſite expelled a BLUE precipitate.—With Marine Acid this Matter alſo, after a conſiderable time, afforded a clear yellow ſolution which Pruſſite alſo precipitated BLUE —Another part of it treated with Cauſtic fixed Alkali was converted into Iron Ochre —Another part was, tho' with difficulty melted into a black Globule by the blow-pipe, but in a moderate heat retained its whiteneſs; with Borax it appeared greeniſh while hot, but colourleſs when cold, and hence he judged it to be SIDERITIC CALX The ſolution from which this had depoſited, being farther diluted and heated to Ebullition, depoſited ſtill more of it, to the amount of about 10,5 grains after which he expelled the Calx of Mangaueſe by Tartarin.*

371. The late great Artiſt Mr WEDGWOOD diſſolved a quantity of black Wadd in a large quantity of Nitrous Acid heated,

* 1 Chy. Ann. 1790. 155.

and adding Tartarin to the solution, obtained first a WHITE precipitate which proved to be Lead, next a RUSTY RED precipitate which was Iron, and lastly a WHITE which on drying became brown, and was Calx of Manganese.

372. IN THE DRY WAY, Mr. WEDGWOOD extracted from it by black flux in a heat of 90°. of his Pyrometer 4,6 per cent. of Lead. According to SCHEELE Manganese is found in the ashes of most vegetables, and to it the BLUE OF GREENISH colour of calcined vegetable Alkali is owing. If 3 parts of the Alkali of Tartar, 1 of sifted ashes, and $\frac{1}{8}$ of Nitre be melted together they form a dark green mass, which dissolved in Water affords a beautiful GREEN solution and this being filtered, on the addition of a few drops of Oil of Vitriol becomes RED, and after a few days a brown Powder deposits, which has the properties of Manganese Mem. Stock. 1774. 189.

The ashes of Serpyllum contain very little of it, those of trees contain most. Ibid. 190.

373. To analyse the Cherry Red Ore of PIEDMONT Chevalier NAPION first reduced it to powder in an Iron Mortar, and then by dilute Vitriolic Acid separated the adventitious particles of Iron.

2. Of this powder well washed and dried, he mixed 200 grains with 200 grains of mild Tartarin and heated it to redness for two hours in a Silver Cup.

3. On this heated mass he poured Water, which reddened, and to this lye gradually added Nitrous Acid, on adding Sugar

Sugar he obtained a colourless solution. This being filtered off, left a residuum weighing 52,25 grains, which proved to be Siliceous.

4. The filtered solution essayed with Vitriolic Acid discovered no Barytes. Treated with Caustic Volalkali the Manganese was precipitated with a small proportion of Calx of Iron. The precipitate well washed and dried weighed 93,12 grains.—The liquor then treated with mild Volalkali afforded a precipitate which weighed after Calcination in a white heat for 1,5 hour 46 grains.

The precipitate No. 4, being calcined to blackness and re-dissolved by dilute Nitrous Acid and Sugar left a residuum weighing 1,5 grains nearly and appeared to be Argill. Mem Turin 1788. 306.

574. To obtain Regulus of Manganese, Take 2 ounces of the white Calx purified from Iron and dried so as not to become brown; make it into a paste with Oil, and dry it gently, then lay it in a crucible lined with Charcoal, of which $\frac{1}{3}$ should be empty and its cover well luted on, heat it moderately for 5 minutes, and violently for $\frac{3}{4}$ of an hour in a forge with the help of a double Bellows loaded

SECTION XIV.

ORES OF URANITE.

SPECIES I.

FIRST FAMILY.

Uranitic Ochre.

375. This Ore has as yet been found mixed only with Calx of Iron. It may be separated from the Calx of Iron, by folution in dilute Nitrous Acid which will take up the Uranitic and reject the Martial Calx.—Or by folution in dilute Vitriolic Acid, which makes the fame election, if any Iron be diffolved it may be precipitated after fome time by Zinc, then the Zinc and Uranite being precipitated by a Cauftic fixed Alkali. An excefs of Volalkali will take up the Zinc and leave the Uranitic Calx.

SECOND FAMILY.

Micaceous Uranitic Ore.

376. Klaproth analyfed this Ore by folution in Nitrous Acid, effayed this folution for Marine Acid by that of Nitrated Silver, but found none. Hence the Marine Acid found in it by Bergman was merely accidental. A Watch fpring dipped into it was coated with Copper, hence

hence he precipitated the solution with Caustic Volalkali. The precipitate thus obtained being blue he added more Volalkali until it ceased to extract a blue colour.—The residuum he re-dissolved in Nitrous Acid, to one portion of this solution he added polished Iron which betrayed no sign of Copper or of any other metal, another portion he saturated with Prussite and obtained a brownish Red precipitate, and a third portion with Caustic fixed Alkali which gave the pure yellow Uranitic Calx.—consequently this substance contained nothing but this Calx, and that of Copper.

SPECIES II.

Sulphurated Uranite.

377. To examine the contents of this Ore. Klaproth employed Nitrous Acid or Aqua Regia, as its best solvents. By applying the former he obtained from 240 grains of this Mineral, six and sometimes 10 grains of Sulphur, 10 or 17 of Silex remained. Precipitating the solution by Caustic fixed Alkali he obtained the yellow Calx.—This he re-dissolved in dilute Vitriolic Acid; after some time Vitriol of Lead deposited in a crystaline form.—The solution being afterwards farther concentrated by evaporation, shot into Lemon coloured accumulated Crystals of Uranitic Vitriol.

378.

378. To OBTAIN THE URANITIC REGULUS. Take 2 or 3 drachms of the yellow Calx, make them into a paſte with Linſeed Oil, dry the paſte in a moderate heat, place it in a crucible lined with Charcoal, with a little of the pureſt pulverized Charcoal or Lampblack ſtrewed over it, lute on a cover and heat it gently for 5 minutes and ſtrongly for ¾ of an hour, ſmall Reguli will be obtained. Hitherto they have been found very friable, which I ſuſpect has been occaſioned by the great quantity of Charcoal ſtuffed into the crucible.

379. RICHTER thinks this imperfect reduction to proceed from Iron, and to free the Uranite from Iron, he adviſes the Nitrous ſolution to be precipitated by TARTARISED TARTARIN and the precipitate to be waſhed with water until it ceaſes to exhibit a BLUE colour with Pruſſian Alkali. (Tartariſed Iron being more ſoluble than Tartariſed Uranite) the reſiduum is then to be dried and heated to redneſs to expel the Tartarous Acid. The yellow Calx then remaining, to be mixed with its weight of dried Ox Blood over which a little Charcoal is ſtrewed and melted in a ſtrong heat for at leaſt an hour. Thus a more perfect Regulus will be found Phoſphoric Acid may indeed be ſuſpected but its quantity muſt be ſmall.

SECTION

SECTION XV.

ORES OF TUNGSTEN.

SPECIES I.

FIRST FAMILY.

WHITE OR GREY TUNGSTEN.

380. To analyſe this Ore, SCHEELE digeſted one part of it in 3 of common pure Nitrous Acid, it ſhortly became YELLOW, after ſometime, he poured off the Acid, edulcorated the yellow powder and digeſted it with two parts (of the original weight) of Cauſtic Volalkali, it became WHITE. Soon after he poured off the Alkali, edulcorated the powder, and treated it again with Nitrous Acid, and after that with Volalkali as at firſt, until it no longer appeared to be diminiſhed; a few grains only then remained and theſe were merely Siliceous.

381. He then examined theſe Acid and Alkaline ſolutions.

1. AS TO THE ACID SOLUTION, a few drops of Pruſſite diſcovered a very minute portion of Iron and no more. Cauſtic Volalkali cauſed no precipitate, and mild Tartarin precipitated a white powder which waſhed and dried, proved to be a mere Calcareous Earth. This then and nothing elſe, was taken up by the Nitrous Acid.

382. 2. The Alkaline ſolution ſaturated with Nitrous Acid depoſited a white powder,

de., which is the ACIDO FULIGINOUS CALX OF TUNGSTENITE.

383. He also analysed it IN THE DRY WAY, which is more expeditious; with one part of the Ore finely pulverized, he mixed 4 of Tartarin and melted them in an Iron crucible. The fused mass he threw into 12 times its weight of boiling water.—What remained UNDISSOLVED by

384. the water he edulcorated and found it soluble with effervescence in Nitrous Acid, and precipitating this solution with Tartarin found it contained nothing more than mere Calcareous Earth.

385. What the Water had taken up namely the Alkaline part, he saturated with Nitrous Acid and thus precipitated a white powder, which washed in cold water and dried proved to be the ACIDO TARTARINATED CALX OF TUNGSTENITE.

SECOND FAMILY.

BROWN TUNGSTEN.

386. KLAPROTH treated 100 grains of this Ore finely pulverized with Aqua Regia formed of equal parts Nitrous and Murine Acids in a boiling heat continued for some time. The Ore became YELLOW as usual, this treatment he continued with fresh additions of Acid as long as any thing could be dissolved. He thus obtained the YELLOW CALX single, as it remained undissolved, and found it to weigh after edulcoration and deficcation

91

91 grains it had all the properties of the YELLOW TUNGSTENITIC CALX.—NOTE this is ſhorter than SCHEELE's method.

387. The Acid employed in digeſtion, and the Water of edulcoration he evaporated to a ſmall volume, and ſaturated this with Cauſtic Volalkali, only about half a grain of Argill and Iron Ochre was precipitated. But this being filtered off and the ſolution warmed treated with Tartarin, a copious precipitate of Calcareous Earth reſulted.

SPECIES II.

WOLFRAM.

388. To diſcover the contents of this Ore at that time little known, the Brothers ELHUYART made ſome preliminary experiments, and in the ſubſequent proceſs diſplayed that penetration and ſagacity for which, on other ſubjects the Spaniſh Nation has long been eminently diſtinguiſhed.

389. 1. They mixed two drachms of this ſubſtance with 4 of Tartarin. This mixture they found fuſible and while in fuſion they poured out on a Copper Plate. There remained a black ſubſtance in the crucible, which after edulcoration weighed 37 grains.

2. They then examined the ſubſtance poured out on the Plate. This they found in great meaſure ſoluble in Water, and adding to this the Water alſo that

had waſhed the ſubſtance in the crucible, they filtered the whole, and found on the filter a light coloured powder which weighed 9 grains. Hence they inferred that the Alkaline ſolution ſtill retained 98 grains.*

390. Hence then 3 ſubjects remained to be examined, the 37 grains that remained unmelted in the crucible, the 9 grains which remained on the filter, and the 98 which the Alkaline ſolution retained.

1. The 37 grains that remained in the crucible, they examined by the blow-pipe and found that a particle of that matter became GREENISH YELLOW in the interior flame, and RED in the exterior. Hence they concluded theſe 37 grains to be a mixture of Iron and Manganeſe.

2. The 9 grains on the filter examined in the ſame manner diſcovered a ſmaller mixture of Manganeſe.

391 3. The Alkaline ſolution treated with Nitrous Acid gave a WHITE precipitate, which was ſoluble in Water, turned infuſion of Turnſole Red, in a word, had all the properties of the ACIDO TARTARINATED CALX, as they afterwards more fully evinced.

Having thus diſcovered the general contents of the Ore, they next proceeded to its Analyſis in the moiſt way, and choſe the Marine Acid as the pro-

* They uſed French weights as appears from this account, for 37+9+98=144 grains=2 Gros.

porest

pereſt ſolvent, both of Iron and Manganeſe.

392. On 100 grains of finely pulverized Wolfram they poured ſo much Marine Acid as to cover it about ¾ of an inch. After an hour's ebullition the powder became YELLOW. The yellow powder they treated alternately with Cauſtic Volalkali and Marine Acid after SCHEELE's method, until no more than 2 grains remained undiſſolved, theſe expoſed to the blow-pipe with Microcoſmic Salt, appeared to be Siliceous with a ſlight mixture of Calx of Tin, as they gave the Salt a milky colour.

393. They next examined both the Acid and Volalkaline ſolutions adding to each the Waters of their reſpective edulcorations and evaporating the Acid ſolutions to the bulk of 4 ounces.

394. 1. They eſſayed the ACID SOLUTIONS thus re-united, by Pruſſite, taking only ⅓ of the ſolution for a trial: they obtained a copious BLUE precipitate, but knowing that this precipitate contained Manganeſe alſo, they ſeparated this from the Iron by the method mentioned No. 357.

395. They next examined the re-united ALKALINE SOLUTIONS, gradually adding or rather dropping a very dilute Nitrous Acid. They thus obtained a copious WHITE precipitate, but obſerving that it was very ſoluble and conſequently that the whole was not depoſited, they threw back the precipitate into the ſolution, and evaporated the whole, firſt to

 dryneſs,

dryneſs, and then to get rid of the Nitrous Ammoniac, calcined the dry maſs under a muffle, and thus obtained the YELLOW CALX OF TUNGSTENITE.

The properties of this yellow Calx, and its capacity of becoming more diſtinctly Acid, they afterwards investigated in a moſt maſterly manner, and thus conſiderably rectified and improved the diſcoveries of SCHEELE.

396. The Analyſis of the Wolfram of POLDICE in CORNWALL by KLAPROTH, was conducted nearly in the ſame manner.— But he remarked that the Acido Tartarinated Calx was ſoluble in 20 times its weight of Water, only while moiſt, for when well dried it required above 150 times its weight to diſſolve it Moſt probably much of the Mineral Acid by which it was precipitated was expelled during deſiccation.

397. TO PROCURE REGULUS OF TUNGSTEN, ELHUYART put 100 grains of the yellow Calx into a crucible lined with Charcoal with a luted cover, and by a violent heat continued for one hour and a half, obtained a Regulus weighing 40 grains but ſo brittle as to fall to pieces betwixt the fingers, however neither KLAPROTH nor any one has ſince ſucceeded in procuring a pure Regulus

It has been ſaid that the Specific Gravity of Regulus of Tungſten was 17,6 but as it appears that Wolfram contains this Regulus, in a conſid rably greater proportion than it does Iron or Manganeſe and probably theſe Metals are in their metallic

metallic ſtate, as WOLFRAM detonates with Nitre, and ſince the Specific Gravity of the whole compound does not exceed 7,2 it is improbable that of Tungſtenite ſhould exceed 7,5.

398. To extract the Acid Calx from Tungſten, RICHTER, mixes two parts of it, finely pulverized with 7 of purified Nitre; fills ½ of a crucible therewith, covers it, and fuſes it in a heat gradually increaſed; the fuſed maſs he pours out on a greaſed tile, or plate of copper warmed. The maſs when cold is diſſolved in warm water, and often exhibits the colours that Mangneſe does, after ſome hours and repeated agitation, he filters it off: the filtered liquor he treats with Vitriolic Acid until the Alkali is ſaturated, and the white Tungſtenitic Calx is thus intirely precipitated. This he then edulcorates and dries. Any other Acid would anſwer as well as the Vitriolic.

To reduce this Calx to Tungſtenite, he mixes it with its weight of deſiccated blood, heats the mixture to redneſs, and then preſſes it into another crucible that it nearly fills, and covering it, expoſes it to a violent heat for an hour at leaſt.

SECTION XVI.

MOLYBDENA.

399. To decompose Molybdena by detonation with Nitre, KLAPROTH mixed one ounce of the pureſt Molybdena with 4 of Nitre and detonated them as uſual. The reſiduum diſſolved in Water, and the ſolution ſaturated with Nitrous Acid, afforded him 320 grains of Molybdenous Acid. However as the Acid thus procured retains ſomewhat of the Alkaline Baſis,———

400. TO PROCURE A PURE MOLYBDENIC ACID, he diſtilled from 240 grains of the pureſt Foliaceous Molybdena 2 ounces of purified Nitrous Acid unto dryneſs, and on the dried reſiduum 2 ounces more unto dryneſs alſo, and laſtly the whole quantity that had paſſed into the receiver. What now remained of the Molybdena was white, but the next day became BLUE which colour it imparted alſo to the Water poured on it. Filtered, waſhed and dried it weighed 140 grains.

401. The Water that waſhed it, being treated with Tartarin depoſited a few grains more, and whiter; but on adding a larger quantity of Tartarin, the depoſited Calx was re-diſſolved; however on ſaturating the Alkali with Nitrous Acid, it was again depoſited to the amount of 25 grains.

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452. The Water of these different washings collected and duly evaporated, afforded him 225 grains of Tartar Vitriolate. Whence and from other experiments he concludes that Molybdena contains about 40 per cent. of Sulphur.* Hence it appears to have been held in solution by the Vitriolic Acid in the washings, and deposited when the Tartarin deprived it of this Acid.

A General Method of Essaying Alloys.

In the dry Way.

Where several metals are contained in an Alloy, Engestrom has used much laudable industry in promoting and improving a general method of separating them successively.†

This method consists in bringing the Alloy consisting, we may suppose of Gold, Silver, Copper and Iron into fusion, by as much Liver of Sulphur as will fuse it, this poured out affords a Regulus of some kind;—Whatever it may be, the *Plachmall* (that is the Hepatized Alloy) is replaced in the crucible, a little Nitre added, and when in fusion poured out again; a Regulus is again found over that Plachmall, and over that a slag. All these are to be separated, and the Plachmall continually melted with Nitre as long as any remains. The slags consist of the Alkaline basis of the Nitre and of that of the Hepar, whose Sulphur

* 3 Berl. Beob. 72

† See Mem. Stock. 1775.

was

way oxygenated or Volatilized. They hold in ſolution that metal to which the Hepar has the ſtrongeſt attraction, and which it ſeems is more ſtrongly attracted by the Alkali than by the Hepar

Theſe ſlags melted with the addition of Tartar yield a Regulus and another ſlag, which with Tartar, yields ſtill more Regulus, until the ſlags are exhauſted, and the different metals obtained, and thoſe that are leaſt connected with Oxygen firſt, as in this caſe the Gold, next the Silver, and then the Copper.

In this manner Mr. ENGESTROM aſſures us he has ſeparated Iron, Copper, Tin, Lead, Silver and Gold. And alſo Iron, Copper, Cobalt and Nickel, the Reguli were not indeed pure, but they might be purified by a ſecond operation.

The Affinities of Liver of Sulphur, according to BERGMAN, are in the following order; Iron, Copper, Tin, Lead, Silver, Gold, Regulus of Antimony, Cobalt, Nickel, Biſmuth, Mercury and Arſenic. Zinc alone is not affected by it, and is, it ſhould ſeem, thus ſeparable from other metals.

According to WENZEL, SULPHURATED SILVER may be freed from Sulphur by the ſuperior affinity of Sulphur to Iron, Copper, Tin or Lead, and remain pure if theſe metals be added in the due proportion neceſſary to take up the Sulphur and neither more nor leſs, if more, the exceſs would unite with the Silver, and if leſs, the whole of the Sulphur would not be taken up. What this proportion is in each caſe will be ſeen in the 3d. Table.

The

The ſeries or gradation of the affinity of Sulphur to Metals above given, beginning with the ſtrongeſt, agrees with that in BERGMAN's Table.

SULPHURATED COPPER, may in the ſame manner be deſulphurated by Iron.*

SULPHURATED LEAD, may be deſulphurated by Iron, Copper or Tin.

SULPHURATED MERCURY, by Iron, Copper, Tin, Lead, Silver or Biſmuth, &c.

ANTIMONY may be deſulphurated by Iron, Copper, Tin, Lead or Silver.

SULPHURATED BISMUTH, by Iron, Copper, Tin, Lead or Silver to which WENZEL adds Reguline Antimony, yet, as to this, he is contradicted by BERGMAN's Table. However BERGMAN adds Cobalt and Nickel to the precipitants of Sulphurated Biſmuth.

In experiments on ſmall quantities by the blow-pipe, the above-mentioned precipitants may often be advantageouſly applied. In other caſes preciſion can ſcarce be attained, for want of a method of aſcertaining and applying the due degree of heat, and becauſe the laſt portions of Sulphur can ſcarely be ſeparated, except from Silver and Lead, by this method.

* Monnet denies this MINERALIZATION. p. 232.

TABLE

OF THE

COMPOSITION

OF

METALLIC CALCES.

THAT Metallic Calces consist of the Metals themselves, united always with Oxygen, and sometimes with Oxygen, Water, and fixed Air, according to the various methods employed for obtaining them, is now generally allowed. It is also well known that the proportion of these ingredients is variable according to the circumstances in which the combination with Oxygen is effected, the presence or absence of the other ingredients, and the degrees of heat at which the Calces are dried. These circumstances I mean to indicate in a general manner in the following Tables, but a particular account of them must here be given, as it is only by an exact similarity in all the essential points of Manipulation, that results exactly similar can be expected, and the Tables rendered of any use as standards of comparison in similar cases.

1. The

1. The experiments on Metallic Calces precipitated from their Acid menftruums by Alkalis, were made by BERGMAN and WENZEL. Gold, Regulus of Antimony and Cobalt were diffolved by BERGMAN in Aqua Regia. Silver, Copper, Lead, Mercury, Bifmuth, Nickel and Manganefe in the Nitrous Acid; Tin, in the Marine; Iron and Zinc in the Vitriolic Acid; Some were made by MORVEAU, whofe precipitant was only common Salt of Tartar. Some by GADOLIN and others; moft were made, where poffible, without heat. The Alkalis employed by BERGMAN were Soda fully aerated, and alfo Cauftic. WENZEL ufed the vegetable only, and that fully aerated. BERGMAN diffolved a Docimaftic Centenary of each of the metals in their appropriated Acids, dried the precipitates firft in a gentle heat, THEN IN THAT OF BOILING WATER FOR 5 MINUTES, and then weighed them.*—WENZEL diffolved 240 grains of each of the Metals, as BERGMAN did, but then he dried them differently, namely at firft in a gentle heat, afterwards BY EXPOSURE TO THE AIR FOR 6 MONTHS, and then weighed them. To find the quantity of fixed Air taken up by each, he re-diffolved the calces thus dried and weighed, in their appropriated menftruums, and from their lofs of weight in this folution, infered the quantity of fixed Air they had taken up, and laftly knowing the conftant weight of the metals employed, namely 240 grains and that of the fixed Air, he difcovered the weight of the additional matter they had taken up, which he fuppofed to be Water, and undoubtedly it partly was fo, but much

* 2 Berg. 391. 406

was alſo Oxygen, as will be apparent by comparing his weights with thoſe of BERGMAN and MORVEAU.†

I reduced both BERGMAN and WENZEL's Tables to Centeſemal proportion, as the moſt convenient, and for the purpoſe of comparing them.

The quantity of fixed Air in the Calces precipitated by aerated Soda not being expreſſed in BERGMAN's experiments, I found, by deducting the weight of the precipitates by Cauſtic Volalkali, from that of the precipitate by aerated Alkali.—In WENZEL's experiments it is noticed by himſelf, thus, 240 grains of Silver, treated in his method, gained he ſays, 0,288 that is 28,8 per cent; but of this 0,158 he ſays was fixed Air, then the remainder, viz. 0,13 or 13 per cent. were Water and Oxygen, and if 113 grains of this Calx contain 13, 100 will contain 11,5. But to find the proportion of fixed Air, I ſay, if 128,8 of the Calx contain 15,8, 100 will contain 12,3: for the Calx that contains fixed Air, contains Oxygen and Water alſo.

BERGMAN's reſults with the Pruſſian Alkali I intirely omit, as being made by a teſt ill conſtituted.

2 The experiments on the Calces formed by detonation with Nitre, were for the moſt part made by Mr. MORVEAU. He dried them in a RED HEAT. But with reſpect to the Calces of Copper, he found their weight the ſame, as when dried by expoſure to the atmoſphere, ſee his Digreſſions Accad p. 184.

3 I have added the extreme quantity of Oxygen, which metals are capable of retaining, when in a dry form. Moſt of theſe experiments were made by WENZEL; the means he uſed were ſolution, precipitation and calcination of the precipitates in a red heat. Some were made by

† Wenzel 263. 264 & 267.

ABICH

ABICH, who employed ſimple, but repeated calcination.

But 4. The chief difference betwixt this Table and all others that have yet appeared is, (beſides its copiouſneſs) the diſtinction I ſet forth between the quantity of Oxygen contained in the Calces, and that of the water which they alſo contain. Upon what reaſons the determination of theſe quantities are founded, will for the moſt part be ſeen in the Notes. Thoſe who may not be ſatisfied with them, may ſtill find the quantity of Metal, and the additional weights gained by the Calces, which remain invariably the ſame, let the parts of which this additional weight conſiſts, be diſtinguiſhed as they may.

ES.

arts of Calx contain

gen.	Water.	Fixed air.	
			Bergman.
	,34	11,77	ergman.
	1,07		ergman.
	,24	12,3	Wenzel.
	1,91		Wenzel.
5	18,75	11,76	Bergman.
	14,7		Bergman.
	24,5	5,5	Wenzel 78.
6	21,76	9,48	Morveau.
			Morveau.
			Tillet.
			Morveau.
			Wenzel.
r 14			
99	29,09	14,38	Bergman.
61	25,17		Bergman.
	26,18	3,73	Gadolin.
5			Gadolin.
17	27,01	6,74	Gadolin.
	uncertain	uncertain	Gadolin.
	2,56		Gadolin.
2	38,08		Wenzel.
6	36,14		Gadolin.
	2,8		Gadolin.
8	39,22	11,3	Gadolin.

contain

Fixed air.	
	Gadolin.
	Gadolin.
	Gadolin.
	Gadolin.
	Gadolin.
	Klaproth.
	Gadolin.
	Gadolin.
	ditto
	Lavoisier.
3,	Bergm. 101.
	Wenzel.
3,	Lavoisier.
0,59	Bergman.
	Ibid.
	Wenzel.
	Morveau.
	Bergm. 437
	Bayen.
	Morveau.
	Morveau 21.
	Ibid.
10,45	Bergman.
	Ibid.
15,7	Wenzel.
	Ibid.
4,76	Morveau.
4,41	Ibid.
2,43	Lavoisier.
	Wenzel.
Tillet.	Mem. Par. 1763.
	Abich.†

of Calx contain		
er.	Fixed air.	
	5,25	Bergman.
		ibid.
	3,66	Wenzel.
		Ibid.
		PER ME.
		PER ME.
		Lavoisier.
	10,3	Bergman.
6		Ibid.
9	7,7	Wenzel.
		Ibid.
		Morveau.
		Wenzel, Abich.
	1,04	Bergman.
		Ibid.
31		Wenzel.
		Morveau.
		Klaproth.
		Morveau 207.
		Morveau.
		Morveau.
7	3,06	Bergman.
		Ibid.
	0,7	Wenzel.
		Ibid.
		Morveau.
		Baumé.
		Bergman.
		Wenzel.
		Tillet. Mem. Par. 1763.

the Calx contain

r.	Fixed air.	
	12,46 ·2,88	Bergman. Ibid. { Air and water. } Klap. Abich.*
	5,2	Bergman. Ibid. Klaproth.
		Berthollet.
	4,	Bergman. Bergman. 2d Bergman 225.
		Elhuyart.

* 3 Q—4

d.

litrous Acid.

l. itri	
	ad Bergman. 391. Wenzel.
Vitric d	a Bergman 391. Wenzel.
Vitrio d	Bergman. Wenzel.
luria dı luriat	Bergman. Wenzel. s Klaproth.

:d by Fuſion.

100 Parts. Sulphur.	
13,	Wenzel.*
20,26	Ibid
19,	Per me.
35,9	Wenzel.
18,4	Per me.
17,3	Per me.
15,3	Wenzel.
14,2	Pelletier.†
20,	Bergman.‡
28,6	Pelletier.
13,2	Wenzel.
21,2	Wenzel.
20,	Pelletier.§
13,44	Wiegleb.‖
13,55	Ibid.
23,	Wenzel.
26,	Bergman.¶
15,	Wenzel.
80,	Weſtrumb.**
20,	Ibid.

‖ Hel et. Magaz. 194

6

NOTES

ON THE

TABLE OF CALCES.

OF GOLD AND PLATINA.

WITH respect to these, I have not as yet been able to limit the portions of Oxygen and Water, a sufficient number of experiments properly varied, not existing. Platina is imperfectly separated from its menstruums by every precipitant.

SILVER.

BERGMAN found the quantity of Mercury necessary to precipitate 100 parts of Silver from its saturate solution in the Nitrous Acid, to be 135 parts This precipitation is effected by the Mercury, in consequence of its taking up the quantity of Oxygen previously united to the Silver. Now LAVOISIER found that 100 parts Mercury dissolved in hot Nitrous Acid, take up 8 of Oxygen. And consequently 135 parts Mercury take up 10,8, this then was the quantity of Oxygen united to the 100 parts Silver. When therefore, the Silver is precipitated, by a sub-

ſtance which does not ſtrip it of its Oxygen, it is natural to uppoſe, that, it ſtill retains it; I ſhould not however rely on this preſumption, if it did not appear, that the weight of the precipitate nearly agreed with it; which in fact it does, for BERGMAN found that 100 parts Silver precipitated by Cauſtic Soda, dried in this manner, weighed 112 grains, the difference is only 112—110,8=1,2 grains, which may well be attributed to the Water retained by the precipitate.—Then if 112 grains of the Calx contain 100 of Metal, 100 grains of the Calx muſt contain 89,28. This is ſufficient to ſhew the method I followed. The almoſt intire agreement betwixt the quantities of Water found both by BERGMAN and WENZEL, and neceſſarily greater in WENZEL's experiment, as he dried his Calx only in the temperature of the atmoſphere, and determined as above ſhewn, confirms the accuracy of the mode of reaſoning here adopted.

COPPER.

31 Parts Copper precipitate 100 of Silver from the Nitrous Acid, and conſequently take up 10,8 of Oxygen. Conſequently 100 parts Copper would take 34,83 of Oxygen, however if this Calx, ſo burthened with Oxygen be heated, even below redneſs it will looſe 6 or 7 per cent. of Oxygen, which explains TILLET's experiments, and if heated to redneſs it will loſe nearly 10 per cent. of Oxygen as MORVEAU's experiment proves.

Copper diſſolved in Aqua Regia, formed of 2 parts Marine, and 1 part Nitrous Acid takes up 25 per cent. of Oxygen. And conſequently 20 per cent. is the quantity of Oxygen that theſe Calces contain.

Copper diſſolved in Vitriolic Acid takes up 32,12 per cent. of Oxygen, this appears from the quantity of Zinc requiſite to precipitate it; for, from BERGMAN's experiments it follows that 146 parts Zinc are neceſſary to precipitate 100 of Copper from a ſolution of Vitriol of Copper, and it will be ſeen in my

my Notes on Calces of Zinc, that 146 parts Zinc take up 32,12 of Oxygen. WENZEL it is true, found that a much smaller quantity of Zinc would precipitate 100 grains of Copper from a solution of Vitriol of Copper, for according to him 108 grains of Zinc are sufficient for that purpose, but then his precipitation was made in a Sand heat, whereas in BERGMAN's experiments no heat was applied till towards the end. 3 BERGM. 139. BERGMAN's therefore was made in a temperature analogous to that, in which Zinc, in the experiment I allude to, and to be mentioned hereafter, was dissolved and oxygenated and the quantity then taken up is that which it would take in a similar temperature. WENZEL's experiment only proves that in a higher temperature it would take more Oxygen.

The small quantity of Oxygen taken up by Copper in the act of deflagration with Nitre, arises from its well known resistance to the reception of Oxygen in the dry way when heated.

IRON.

Mr. LAVOISIER in the Memoirs of PARIS for 1782, has shew that Iron precipitated from its solution in Vitriolic or Marine Acid gains 27,22 per cent. of Oxygen; upon this principle my calculation is founded. By combustion in pure air it gains near 33 per cent. By solution in dilute Nitrous Acid about 30 per cent, and in strong or hot Nitrous Acid from 40 to 45 per cent. or more.—But different sorts of Iron gain different proportions of Oxygen, because not being equally metallized, they already contain it in different proportions; hence the most perfect Iron gains most weight by calcination or solution in Acids, and the least perfect gains least But Iron that has taken up above 33 per cent. of Oxygen is apt to lose much of it in a red heat, which chiefly arises from the Water contained in it, and hence the use of roasting Iron Ores. But in a stronger heat long continued it will gain more, yet in a still stronger, as in that

of the Focus of a burning Glafs, it will again lofe it. The Calces precipitated from the Vitriolic or Marine Acids expofed to a red heat, gain Oxygen as we fee in the Table.

TIN.

The calculation of the proportion of Oxygen in Calces when this Metal has been diffolved by dilute Nitrous Acid or Aqua Regia, is founded on two experiments, one by BERGMAN and the other by KLAPROTH. BERGMAN found 88 grains of Tin, capable of precipitating 100 grains of Silver from the dilute Nitrous Acid, in the temperature of 60°. It was not until a fhort time after, that the Tin thus diffolved became further oxygenated and the folution turbid. confequently 88 grains of Tin took up 10,8 of Oxygen, and 100 fhould take 12,27. Again KLAPROTH found that 89 grains of Tin or 88, precipitated 43 of Copper from Aqua Regia. Now 100 parts Copper diffolved in Aqua Regia take up, as we have already feen, 25 of Oxygen, confequently 42 take up 10,75; this quantity of Oxygen was therefore taken up by 89 grains of Tin, nearly as in the former cafe, and 100 grains of Tin take up 12,08 of Oxygen or fomewhat more, for 1 grain of the Tin was fo far oxygenated as to remain undiffolved, and thus alfo the proportion of Oxygen affigned to Copper in Aqua Regia is farther juftified.

The calculation with refpect to Vitriolic Acid, is founded on MORVEAU's experiment Digrefs. Accad. 202 By which it appears that 100 parts Tin take up when THUS treated 30 per cent. of Oxygen.

The calculation with refpect to Nitrous Acid, is grounded on BAYEN's experiment, in which Tin takes 31 per cent of Oxygen. BAYEN SUR L'ETAIN.

With refpect to Aqua Regia it muft be remarked that the proportion of Oxygen taken up by Tin depends much on the proportion of Nitrous and Marine Acids which form that Menftruum. And this proportion

tion cannot be known unless their respective Specific Gravities as well as weights be set forth. A circumstance too much neglected by most Chymists.

LEAD.

That Lead when dissolved in Nitrous Acid does not take up above ½ the quantity of Oxygen which unites to it when it is converted into Minium, I infer from various considerations.

1. BERGMAN found that 100 grains of Silver required to precipitate it from the Nitrous Acid 234 of Lead. But of these only 224 were really dissolved, as he acknowledges. Now 100 grains of Silver take up 10,8 of Oxygen, and hence 100 of Lead should take up 4,9 or nearly 5, but as he applied heat which dissipated part of the Acid, it is probable that the whole of the Oxygen was not communicated, but the loss was inconsiderable.

2. In the solution of 100 grains of Silver, 14 Cubic inches of Nitrous Air are given out, and in the solution of 100 grains of Lead only 8 are produced,* Therefore more Nitrous Acid is de-composed by ½ nearly, in the solution of Silver, than in the solution of an equal quantity of Lead. 3. It appears nevertheless by WENZEL's experiments that the same quantity of the same Nitrous Acid, that would dissolve 100 parts Silver would dissolve (being further diluted) 186 of Lead. It is plain therefore, considering that 186 of Lead produce by the above proportion, about 14 of Nitrous Air, that nearly the same quantity of Nitrous Acid is de-composed in both cases, and consequently the same quantity of Oxygen taken up, or a little more for as 100 8 :: 186. 14,88 4. That Lead in Minium is united to much more Oxygen than it takes in the act of solution from the Nitrous Acid, is evident from this,

* See my experiments in Phil. Transf. 1782. The quantity of Acid I used was greater than in dissolving Silver, as I did not apply heat, nor dilute the Acid sufficiently.

 that

that the Nitrous Acid discolours and deoxygenates or takes Oxygen from Minium, as Mr. LAVOISIER also remarked. Mem. Par. 1781. 482.

From an experiment of Mr. MORVEAU's one would be apt to infer that Lead by solution in Nitrous Acid gained above 14 per cent. of Oxygen, but it must be remarked that the Calx he obtained was dried by distillation in a Retort, to which certainly sufficient heat was not applied to expel all the Water; besides, as 14 per cent. is a greater quantity than Lead takes up even in its conversion into Minium, this quantity could not be communicated by Nitrous Acid, which I have just said deoxygenates Minium.

In Minium Lead takes up about 12 per cent. of Oxygen, as LAVOISIER has shewn, that is, if the Minium were all equally calcined. (which seldom is the case) and contained no Water, 100 parts of it would contain 89,2 of Lead and 10,8 of Oxygen. But in general the proportions are as in the Table.

Marine Acid is oxygenated by distillation over Minium, but not by distillation over Litharge, tho' this last by TILLET and WENZEL's experiments contains more Oxygen. 1 HERMST. 176.

MERCURY.

The small quantity of Oxygen contained in the precipitates by Alkalis, according to the experiments both of BERGMAN and WENZEL render it probable that their solutions were made in a very moderate heat, not exceeding 70 or 80 degrees. According to 1 BERGMAN, 50. Mercury gains by precipitation by mild Alkalis $\frac{1}{4}$ of its weight. This must be an error of the Press.

The precipitate PER SE of the shops rarely contains as much Oxygen as I have assigned to it, as some particles of uncalcined Mercury are often found in it, some portion of fixed Air also, rarely exceeding 2 per cent.

ZINC.

It appears by the fundamental experiment of LAVOISIER, namely that in which he discovered that 100 parts Silver dissolved in Nitrous Acid, take up 10,8 of Oxygen, and the experiments of BERGMAN on the precipitation of Silver by Zinc, it appears, I say that 100 parts Zinc take up in solution in Nitrous Acid 36 per cent. of Oxygen, and not barely 19,637 as LAVOISIER infered. BERGMAN observed that 55 parts Zinc were necessary to precipitate 100 of Silver from its solution in Nitrous Acid, but that 37 of the Calx of Zinc were precipitated, or fell with the Silver; how much Metallic Zinc remained in the solution, or was contained in the 37 of Calx remained uncertain.

To understand what passed on this occasion it is necessary to observe that the same quantity of Nitrous Acid that dissolves 100 parts Silver dissolves only 30 of Zinc, as appears by WENZEL's experiments * 30 grains Zinc then take up as much Oxygen as 100 of Silver, and consequently 100 of Zinc take 36 of Oxygen. Yet 30 grains Zinc are not sufficient to precipitate 100 grains Silver, by BERGMAN's experiment, but 55 must be employed; the reason of this is deducible from an observation made by BERGMAN himself.

Zinc, he observed, being applied to a solution of Silver EXCITES HEAT, consequently it not only takes up part of the Oxygen united to the Silver, but also part of that contained in the un-decomposed Nitrous Acid, that holds the Silver in solution; nay it acts principally upon this as its affinity to Oxygen is much greater than the affinity of Oxygen to Nitrous Air; since this last affinity is inferior even to that of Silver to Oxygen. Its action is so powerful on Nitrous Acid that no Nitrous Air can be had from its solution in that Acid. Hence therefore more Zinc

* *And by my own were heat applied. See Phil. Transf.* 1782.

must

muſt be applied to precipitate Silver, than the bare quantity that is capable of taking up as much Oxygen as is contained in the Calx of Silver This exceſs amounts to 25 grains, as BERGMAN has ſhewn; how much of it is contained in the ſolution and how much in the precipitate of 37 grains we ſhall now ſee.

30 Grains of Zinc take up 10,8 of Oxygen, then 55 take up 19,8 both make up 74,8 of Calx of Zinc. Then if 74,8 of the Calx of Zinc contain 55 of Metallic Zinc, 37 (the quantity depoſited) will contain, 27, and conſequently 28 will remain in the ſolution, which is nearly the quantity that it ſhould contain, according to the theory here ſtated, the DEFICIT of 2 grains is owing to the decompoſition of the Acid which does not leave a ſufficiency of undecompoſed Acid to hold 30 in ſolution.

With reſpect to the quantity of Oxygen taken up by Zinc when diſſolved in the dilute Vitriolic Acid, no direct experiments have been made to aſcertain it. By Mr. CAVENDISH's experiments it appears that 140 cubic inches of Inflammable Air are produced during this ſolution. And ſince he found Marine Acid to produce alſo the ſame quantity of that Air, and as no Sulphureous Acid is found mixed with it, it is highly probable at leaſt, that the Zinc receives its Oxygen from the decompoſition of Water ſolely, and not from the decompoſition of the Acid; this being allowed the quantity of Oxygen taken up by the Zinc is eaſily determined. 140 cubic inches of Inflammable Air weigh by my determination 3,64 grains and the proportion of this Air in Water, is to that of Oxygen as 14 to 86 conſequently 3,64 grains were united in this experiment to 22 of Oxygen, and theſe 22 were taken up by 100 grains of Zinc.

BERGMAN found that 38 parts Zinc precipitate 26 of Copper from 100 parts Vitriol of Copper, therefore 146 parts Zinc would precipitate 100 of Copper from the Vitriolic Acid And if 100 parts Zinc take up 22 of Oxygen as here ſhewn, 46 ſhould take up 32,12, this then is the quantity of Oxygen taken up by 100 parts Copper as above ſaid.

It

It follows from what has been said that Zinc acquires the same quantity of Oxygen by solution in the Marine as in the dilute Vitriolic Acid.

REGULINE ANTIMONY.

The quantity of Oxygen taken up by Reguline Antimony has been inferred from the quantity of this semi-metal employed in precipitating 100 parts Silver from the Nitrous Acid BERGMAN found 82 parts of this semi-metal requisite to effect this precipitation, but as this semi-metal is known to effect a total decomposition of this Acid, I suspect, that 83 parts of it took up much more than 10,8 of Oxygen, however, from this experiment it would follow, that 100 parts of the Regulus take up 13 of Oxygen.—The following experiment shews it takes much more. When this substance is dissolved in Aqua Regia, it takes its Oxygen from the Nitrous, and not from the Marine Acid, whose sole office seems to be, to keep the Oxygenated Regulus in solution; consequently it should take up the same quantity of Oxygen. Now 70 parts Zinc are necessary to precipitate 100 parts of the Regulus from Aqua Regia, therefore 70 of Zinc take up the Oxygen united to the Regulus; but we have already seen that 100 parts Zinc take from Nitrous Acid 36 of Oxygen, therefore 70 take up 25,2 this then is the quantity of Oxygen really taken up by 100 parts of the Regulus when dissolved without heat, but if heat, and fresh quantities of Nitrous Acid be added, it may be made to take up 20 per cent. On the other hand if it be rapidly dissolved in Nitrous Acid, it will in this single operation, from the inability of this Acid to hold it in sol tion, take up much less, as appears by MORVEAU's Experiments.

BISM UTH.

BISMUTH.

49 Parts Zinc precipitate 100 of Bismuth from the Nitrous Acid, and as 49 parts Zinc take up 17,64 of Oxygen, we are led to conclude that 100 parts Bismuth receive from the Nitrous Acid, in the mean temperature of the Atmosphere 17,64 of Oxygen.— This conclusion however might appear doubtful, as Zinc in many cases takes up not only the Oxygen united to the dissolved metals, but strips also the Acid that holds them in solution of part of its Oxygen, and thus acquiring it from two sources leaves it somewhat doubtful how much it takes from each. But in this case no such doubt can subsist, as we find that 49 parts Zinc is almost exactly the very quantity that a saturate solution of Bismuth can take up. For (by WENZEL's experiments) it appears that the same quantity of Nitrous Acid that dissolves 42 grains of Zinc dissolves 84,5 of Bismuth, consequently the quantity that dissolves 98,5 of Bismuth dissolves 49 of Zinc, therefore Zinc takes from the saturate solution of Bismuth, or rather from the dissolved Bismuth just the same quantity of Oxygen as it would have taken from the Acid alone if there had been no Bismuth dissolved in it, and needs no more; and in fact no undissolved Calx of Zinc is observed in this case as is found in other cases where the Acid is preyed upon.

LAVOISIER, misled by the experiment on the precipitation of Silver by Zinc which we have already related, infered that 100 parts Bismuth took up but 9,622 of Oxygen, which is less than even Silver takes up. But the far greater quantity of Nitrous Air afforded by the solution of 100 grains Bismuth than by that of an equal quantity of Silver evidently shews that the Acid is much more deoxygenated by the former than by the latter metal.

Bismuth is not totally precipitated by Water, but if a sufficiency of this liquid be added very little will be retained.

COBALT

COBALT.

From BERGMAN's experiment on the precipitation of Silver by Reguline Cobalt, it follows that 100 parts of this Regulus take from the Nitrous Acid, 29,19 of Oxygen.

KLAPROTH found 47 parts Reguline Cobalt to afford, when precipitated from Nitrous Acid by mild Tartarin, a Calx weighing when not dried by a red heat 70 grains; then 100 parts of this Regulus would acquire an additional weight of 33 grains by a similar treatment. 1 BERL. BEOB. 184. But of this, part must be Water and possibly fixed Air.

NOTES

ON THE

SECOND TABLE.

VITRIOL OF SILVER.

BERGMAN has varied much in his determination of the quantity of Silver contained in 100 parts of this ſubſtance; in his Table of the Weights of Metallic Precipitates Vol. II. p. 391. he aſſerts that 134 grains of it contain 100 of Silver, if ſo, 100 grains of it ſhould contain 74,626 of that Metal. Yet in the ſame Volume p. 420. he ſays that by reduction only 68,75 grains of Silver are obtained from 100 of this Vitriol. And Vol. III. p. 20. he affirms "that "only 66,7 parts of Silver are contained in a Centner "of this Vitriol, as appears both by precipitation and "reduction." Theſe variations may be attributed to the various modes of deſiccation which he uſed.

WENZEL's determination on this as almoſt on every other occaſion where he was not miſled by a falſe theory, or deceived by circumſtances not known at the time he wrote, is perfectly juſt. For inſtance in this caſe, being ignorant of the quantity of Oxygen which attaches itſelf to Metals diſſolved in Acids or otherwiſe calcined, he attributes its weight, for the loſs of which he could not otherwiſe account, to the Acid. And hence attributes to 100 parts of this Salt 68,75 grains

grains of Silver and 31,25 of Acid.—These errors I have corrected, adding in every case the quantity of Oxygen, discovered as shewn in the Notes on the former Table.

VITRIOL of MERCURY.*

By BERGMAN's Table 119 grains of Vitriolated Mercury contain 100 of Mercury, then 100 grains of this Vitriol should contain 84,03 of Mercury. Yet p. 423 he tells us that from a Centner of Vitriolated Mercury only 44 of Running Mercury can be had, and forms his calculation on this proportion. The first determination however appears to me the nearest to the truth.

According to WENZEL IN PRECIPITATES OF MERCURY BY THE VITRIOLIC ACID,† 576 grains of precipitate dried in a Sand heat afforded 453 of Running Mercury; then 100 grains of such precipitate should contain 79,89 of Fluid Mercury, this proportion is nearly just, and preferable to the former.—In Mercury and Silver however, not precipitated, but dissolved by Vitriolic Acid, the proportions are different; hence no inference to the prejudice of these determinations can be drawn from WOLFE's experiments in Phil. Transf. for 1776.

VITRIOL of LEAD.

In this case both BERGMAN's and WENZEL's determinations nearly agree. I suspect however that BERGMAN's is the most accurate of the two, as WENZEL applying a low red heat tho' but for ¼ of an hour seems to have dissipated a minute portion of the

* See Mon. Diss. Met. 305. and 3 Gren. 195 196.

† Wenzel properly distinguished these from SOLUTIONS in that Acid, in which the proportions of Acid and Silver are different.

Acid. Bindheim, who barely dried his Vitriol of Lead, from 105 grains, obtained by reduction by 3 parts black Flux, only 64 of Lead, which is about 61 per cent. 5 Berl. Beob. 179.

MURIATED SILVER.

Here alſo, the agreement of Bergman and Wenzel's reſults is exceeding cloſe, becauſe both uſed the pureſt Silver; Margraaf uſed Silver purified only by cuppellation, and hence and perhaps from inſufficient deſiccation his reſult differs ſomewhat from theirs. For he tells us that from 960 grains of ſuch Silver he obtained after gentle deſiccation 1264 grains of Luna Cornua* conſequently 100 parts of ſuch Muriated Silver contained 75,949 of ſuch Silver. An exceſs which ſhews that the precipitate was not ſufficiently dried, or that it ſtill contained ſome Copper; and if this laſt were the caſe its quantity might thus be diſcovered; for taking a Medium between Bergman's and Wenzel's experiments 100 grains of Muriated Silver ſhould contain 75,2 of Silver, and all that exceeds this weight muſt be Copper: then in Margraaf's Silver the quantity of Copper was 75,949—75,205=0,744 per cent.

Wenzel dried his precipitate in a heat he tells us ſufficient to expel all the Nitrous Acid that might be ſuſpected ſtill to adhere to it, and therefore in a Sand heat; Bergman's mode of deſiccation I have already mentioned. Magraaf it is true thought that no Copper could be contained in his precipitate as he ſuppoſed that the Marine Acid would have taken it up, or at leaſt that the Muriated Copper, if any adhered to the precipitate, would have been, being very ſoluble, waſhed off by repeated edulcoration; but Bergman well remarked that this ſuppoſition was erroneous, for the Muriated Copper adhered ſo cloſe to the Muriated Silver that this laſt did not blacken when expoſed to the Sun for ſeveral days. 2 Bergm. 418.

* Margr. 1 Theile 260.

NOTES

NOTES

ON THE

THIRD TABLE.

ALL metals, Gold and Platina excepted, are capable of uniting with Sulphur both in the moist and in the dry way. Zinc alone takes it with so much difficulty at least in the dry way, that many have doubted of its capacity of assuming it.

It seems however that oxygenation, tho' in the slightest possible degree, necessarily precedes the reception of Sulphur even by the metals most capable of receiving it, and that have the strongest affinity to it.—Hence Metallic Calces are also capable of receiving it, and often more copiously than when nearly in their perfect metallic state, tho' in such case it should seem that much of the Oxygen is divided between them.

Most of the experiments on which the foregoing Table is founded were made by the exact and laborious WENZEL. He generally heated his metals to redness, then poured on them an EQUAL weight of flowers of Sulphur, covered the crucible and suffered it to remain in the fire until the flame of the Sulphur ceased to issue from under the cover.

To discover the effect of a higher degree of heat, and of the exclusion of Air, I mixed Sulphur and Iron,

Iron, and alſo Copper and Sulphur, ſometimes in the proportion of $\frac{1}{4}$ of the former to $\frac{3}{4}$ of the metals, and ſometimes in the proportion of 5 parts of the former, with one part of the metals, placed them in crucibles, which they nearly filled, to which covers were luted, and gradually heated them in a forge to at leaſt 130° of WEDGWOOD, and then ſuffered them gradually to cool.

SILVER.

Silver and all the following metals are capable of uniting to Sulphur in various proportions, in the Table the extreme or greateſt proportion which they can take up in the given circumſtances, is alone given. Sulphurated Silver is black like the Vitreous Ore, and ſo much the more brittle as the proportion of Sulphur is greater.

COPPER.

In WENZEL's experiments leaf Copper was employed, and the compound not melted, but converted into a brittle dark brown ſlag, which he ſays was more fuſible than mere Copper. In mine the compound was compleatly melted, and formed a maſs externally black but internally lead grey, reſembling the Vitreous Copper Ore. Luſtre 2. Metallic. Hardneſs 7. brittle.—By calcination in a low red heat for two hours, of 244 grains of this Sulphurated compound, it loſt 4 grains of its weight, but being ſuffered to cool during the night, it recovered 2 grains of the loſt weight, and being then expoſed to a ſtrong red heat it ACQUIRED ſo much Oxygen as to weigh 262 grains and became of a purpliſh colour.—By comparing this with WENZEL's experiment we ſee that Copper in the dry way acquires no more than a certain proportion of Sulphur, let the quantity of this laſt preſented to it be ever ſo great, and whether the Air be excluded or not, and the heat beyond ignition

ignition ever so high, the limit seems to be 26,25 per cent. 2d. That in a low red heat part of the Sulphur may be expelled from it, but that afterwards, what remains, attracts Oxygen from the Atmosphere, and consequently it should seem that the aspersion of powdered Charcoal would promote its desulphuration. This oxygenation of Sulphur in a moderately high red heat, has also been remarked by MONNET, but in that case he says it is much more disposed to Vitriolization that when calcined in a lower heat.* According to CRAMER this increase of weight of Sulphurated Copper may amount to 28 or 30 per cent.†

A Dutch society consisting of Messrs. DIEMAN, PAETS VAN TROOSTWYK, NIEUWLAND and BONDT effected the union of Sulphur with Copper, and some other Metals in a low heat, and attended with remarkable circumstances, they inserted filings of these Metals with different proportions of Sulphur into a small Glass Phial, out of which common Air was excluded, being in some cases exhausted, and in other cases the Phial filled with Fixed Air, Inflammable Air or Mephitic Air, and in other cases with Water or Mercury; and in some the Sulphur was washed with Caustic Volalkali, to take up any part of it that might be acidified. The Phial being heated over burning Coals the mixture swoll, some Sulphur sublimed, Air was produced, either Hepatic or Vitriolic; the Metals became RED HOT, in some cases as it seems with INFLAMATION, notwithstanding the exclusion of pure Air, and the Metals became sulphurated, these experiments were repeated by VON MONS, RICHTER and others with much the same results‡.

In these circumstances I think the IGNITION proceeded from the excess of the Specific heat of the Sulphur and Copper before their union, over that retained by them after their combination. The Oxygenation

* Sur la Vitriolization. p. 90.

† Edition of 1774. 2 Theile p. 184 in Folio.

‡ 2 Chy. Ann. 1793. 385. &c.

of

of the Metals proceeded from the de-compofition of Water ftill adhering to them, while the Inflammable part of the Water taking up part of the Sulphur formed Hepatic Air,* the flame might proceed from the ignition of the Sulphur in its VAPOROUS STATE, and the Vitriolic Air from the femi-oxygenated Sulphur, of which according to VON MONS Flowers of Sulphur cannot be deprived, even by Volalkali.†

The proportions that produced moft ignition or flame were 40 Copper and 15 Sulphur, but as part of the Sulphur fublimed, and the compound was not weighed, how much Sulphur was taken up is uncertain. The Copper thus fulphurated was very flightly oxygenated, for with Nitrous Acid it gave out the fame quantity of Nitrous Air, as another mixture which had not been ignited.‡

IRON.

In WENZEL's experiment the Sulphurated Iron formed a fpongy mafs; in mine it was completely melted, and compact, externally black, internally whitifh grey, texture granular in part, and partly fibrous, Hardnefs 8. and ftrongly magnetic. When powdered and expofed to the Air it increafed in weight, as it did even during calcination in a low red heat.

MONNET made the fame experiment as I did, but his crucible was not accurately covered nor the heat fo ftrong; from 3 parts Iron Nails and 1 part Sulphur he obtained a ftriated mafs which weighed 4,5 parts, confequently it contained but 10 per cent. of Sulphur.

Natural Pyrites often contain above 36 per cent. of Sulphur, HENCKEL PYRITOL: 208. And their proportion to Iron is ftill higher, as befides it they contain from 6 to 8 per cent of Argill or other foreign matter.

* Ibid. 392. 394.

† 44 Roz. Jour. 395

‡ 2 Chy. Ann. 397.

The

The moſt oxygenated Calx of Iron is alſo combinable with Sulphur, as MONNET has ſhewn. MINERALIZATION p. 286. and Diſſol. des Mett. 57.

DIEMAN and his aſſociates found Iron and Sulphur to inflame in the ſame circumſtances as Copper and Sulphur in the experiments above-mentioned; the proportion that ſucceeded beſt was that of 3 parts Iron to 1 of Sulphur but ſo large a proportion of Sulphur is not abſorbed by the Iron; RICHTER having mixed 48 parts of Iron filings with 16 of Sulphur and treated them as the Dutch Philoſophers, found the reſiduum to weigh only 58 grains, hence 100 parts Iron take up in theſe circumſtances only 20,83 of Sulphur.—That Water is de-compoſed in this experiment appears clearly from the experiment in SCHEELE ON FIRE. §. 81.

TIN.

According to BERGMAN, Tin may take up in the common proceſs of fuſion 25 per cent. of Sulphur, but by WENZEL's experiments, with which PELLETIER's nearly agree, only 18,12. . . . PELLETIER ſays 100 parts Tin weigh after Sulphuration 116,5. Yet he allows only 15 grains of Sulphur to 100 of Tin, the other grain and half he then probably conſiders as Oxygen; a ſuppoſition which appears to me juſt, tho' as it is impoſſible to eſtimate the quantity of Oxygen with preciſion; I made no mention nor allowance for it in the Table.* Both WENZEL and PELLETIER remarked that Tin thus ſulphurated acquired a Lamellar or Micaceous texture, and in colour alſo reſembled Molybdena. Yet according to BERGMAN its colour is whitiſh, and its texture Fibrous. 3 BERGM. 157.

Tin thus ſulphurated is ſoluble in Marine Acid.†

* 13 Ann. Chy 287.

† Ibid. 306.

Sulphurated Tin may by mere Oxygenation and particular management be made to take up double the quantity of Sulphur it had at first absorbed as PELLETIER has shewn, 13 Ann. Chy. 292. by his 13 and 14th experiments it appears that the more it is oxygenated the more it is capable of taking up.

According to BERGMAN in the process for making AURUM MUSIVUM it takes up 66 per cent. of Sulphur—Mr. WOLFE found Musive Gold insoluble in Acids. In DIEMAN's experiments, Tin and Sulphur united, with the same appearances as Copper and Sulphur, and the same proportions were necessary.

LEAD.

It takes up about 15 per cent. of Sulphur, If kept too long in the Fire it turns to a black dust. HENCK. PYRITOLOG. 297.

In DIEMAN's experiments, 45 parts Lead and 15 of Sulphur, fired, as the former Metals.

MERCURY.

In DIEMAN's experiments, Mercury and Sulphur do not inflame. 44 Roz. 394. Yet if Mercury, Sulphur and Water be made into a paste, the Water here also is de-composed, for the mixture affords Hepatic Air when heated. 1 Chy. Ann. 1794. 302.

ZINC.

It appears by the experiments of DEHNE and MORVEAU* that Zinc really has an affinity to Sulphur tho' by reason of its rapid Calcination and the dispersion of its Calx, at the moment of its formation it can while in nearly its Metallic state be scarcely united to it, at least in the dry way.—Even in its calcined state, it is

* 6 Chy. Jour 51. Mem. Dijon 1783 39.

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not easy to unite it with Sulphur, as Sulphur begins by stripping it of much of its Oxygen, and thus approaching to its Metallic state, it recovers in great measure its Volatility. However MORVEAU actually produced a Grey Blende by fusion of Calx of Zinc and Sulphur. In DIEMAN's experiments 45 parts Zinc and 15 of Sulphur burned with explosion.

REGULINE ANTIMONY.

BERGMAN found Native Antimony to contain 26 per cent. of Sulphur and consequently that 100 parts of the Regulus can take up 35,12 of Sulphur, on the other hand WENZEL has shewn that by fusion it can take up only 29,87 per cent. Hence we see the great difference between Metals sulphurated in the moist and in the dry

BERGMAN has also shewn that Glass of Antimony may contain about 4,33 per cent. of Sulphur, and yet still it remains a Calx. Hence a small proportion of Sulphur is not incompatible with a Calciform state.

In DIEMAN's Experiments, Sulphur and the Regulus did not inflame, probably by reason of the small action which Vitriolic Acid has on the Regulus.

BISMUTH,

Did not inflame nor burn in DIEMAN's Experiments. 2 Chy. Ann. 1793. 389.

COBALT,

Did not burn in DIEMAN's experiments. 44 Roz. 394.

EXPERIMENTS

ON THE

COMPOSITION AND PROPORTION OF CARBÓN,

IN BITUMENS AND MINERAL COAL.

An exact knowledge of the component parts of the different Species of Mineral Coal, and alſo of Bitumens (ſubſtances which moſt of them contain) forms an object of ſome importance, not only to the naturaliſt, whoſe views are merely ſpeculative, but to the Practical Œconomiſt who wiſhes to extract from each Species all the advantages it is capable of yielding, and to be enabled to compare the various kinds afforded by different countries, in order to obtain and employ that which ſhall on the compariſon appear to him beſt ſuited to his intentions.

In effect Coals are not only applicable to the more uſual purpoſes of combuſtion, an uſe ſimple as it may appear, attended according to their various Species, with a conſiderable difference of calefactive power both in intenſity and duration, but alſo to the production of Varniſhes much more advantageouſly applicable in many inſtances than thoſe extracted from the Vegetable Kingdom, as Lord DUNDONALD has diſcovered, and abundantly proved,* and alſo of that charred reſiduum called COAK, the only one that can be reſorted to in many caſes, and in moſt, ſuperior to Vegetable Charcoal.

Coals and Bitumens are however ſubſtances that reſiſt the uſual modes of Analyſis, they elude the action of Aqueous, Acid, Alkaline or Spirituous Menſtruums.

* Upon the moſt minute inquiry, why Coal Varniſh is not more commonly employed in paying the bottoms of Ships, I have been informed the principal reaſon is that it ſucceeds TOO WELL. The Ships not requiring ſuch frequent repair.

truums, and diſtillation the only mode hitherto uſed, confounds and varies their natural contents.

Reflecting on theſe obſtacles to an exact diſcrimination of Bitumens and Coals, and of the various kinds of theſe laſt, it occured to me that partly by combuſtion, and partly by their efficacy in decompoſing Nitre, the ſecret of their internal compoſition might poſſibly be unveiled.

1. COMBUSTION, I have obſerved that all the Species of ſolid Bitumen properly ſo called, when laid on a Red hot Iron burn with a large bright flame, ſmoke and ſoot, leaving none or ſcarce any coaly reſiduum and only a little Aſhes.

That the ſofter Bitumens as Maltha burn in the ſame manner, leaving no Coal, but only a little Aſhes, and requiring no increaſe of heat for their entire conſumption.

That Aſphalt burns with flame and ſoot, but melts and ſwells, and requires for its entire conſumption, an increaſe of heat, leaving ſcarce any Coal, and but little Aſhes.

It is moreover well known that liquid Bitumens contain Inflammable Air and Carbon. That they abſorb Atmoſpheric Air when long expoſed to it and light. That in conſequence of this abſorbtion they are thickened, blackened and condenſed firſt into Mineral Tar, then into Mineral Pitch or Maltha and laſtly into Aſphalt. That almoſt all Species of Mineral Coal yield more or leſs of both Species of Bitumen on diſtillation leaving a ſhining coaly reſiduum, but that the proportion is variable in every Species according to the degree of heat applied, that the reſiduum always obſtinately retains a proportion of Bitumen, and that conſequently diſtillation, in addition to its other imperfections, is an inſufficient medium whereby to diſcern the proportion of Carbon and Bitumen, and conſequently to diſcriminate the various ſorts of Mineral Coal from each other.

2. DECOMPOSITION OF NITRE, It has long ago been remarked by the juſtly celebrated MACQUER,* that Nitre detonates with no only Inflammable

* 1 Diction. Chy. 2d Edition 481.

mable matter, until ſuch matter is reduced to a Coal, and then only in proportion to the Carbonaceous matter it contains. An obſervation the truth of which will fully appear in the ſubſequent experiments.

Hence it occured to me, that ſince in the act of detonation, Nitre is always totally or partially decompoſed, and ſince, where Carbonaceous compounds are employed, this decompoſition ariſes ſolely from the mere Carbonaceous part, and every thing elſe being equal, is proportioned to the quantity of mere Carbon they contain, and ſince moſt Species of Coals are compounds of mere Carbon and Bitumen as appears by the products of their diſtillation, it ſhould follow that by the decompoſition of Nitre, the quantity of mere Carbon in a given quantity of every Species of Coal may be diſcovered, and this being known, that of Bitumen may be inferred, and the other un eſſential ingredients being detected by incineration, the whole contents of coaly ſubſtances might be aſcertained

The compoſition of Bitumens alſo, as far as relates to their proportion of Carbon and Oil, may be evidenced in the ſame manner; and here it is to be obſerved that the Bitumens I here conſider are thoſe that are found in a dry or ſolid ſtate, and that theſe contain a larger proportion of Carbon than the liquid Bitumens, for tho' theſe laſt alſo, contain Carbon, it being an eſſential component part of all Oils, yet this portion does not extricate or educe any Air from Nitre nor conſequently contribute to its decompoſition, as the ſubſequent experiments ſufficiently evince, but is conſumed partly by the pure Air ſpontaneouſly emitted by Nitre during its ignition, and partly by the ambient Atmoſpheric Air.

Nay, when Mineral Coal is employed in the decompoſition of Nitre, the ſhare which the mere Carbonaceous part of the Bitumen contained in it, contributes to the decompoſition, will be found ſo ſmall, that it merits no conſideration in the general account.

The firſt ſtep towards carrying this analytic plan into execution, muſt therefore be to determine the quantity of pure Carbon neceſſary to decompoſe

a given

a given quantity of pure Nitre. But here many practical difficulties occur, which ſhall preſently be mentioned. The moſt perfect method of obviating them, was that employed by the ever memorable LAVOISIER; he mixed the pureſt Nitre with Charcoal alſo purged of the Inflammable as well as other Airs and Water which it uſually abſorbs, in the proportion which after ſeveral trials he found requiſite for the entire decompoſition of that Salt, rammed them into a Copper tube, fired them, and continued the Inflammation under Water, by which means the Charcoal was acted on ſolely by the Air educed from the Nitre, to the intire excluſion of the external Air, and this Air was educed, ſolely by the ignited Charcoal, to the intire excluſion of external heat; advantages that cannot be procured by the uſual mode of effecting this decompoſition; thus he found the proportion of Charcoal neceſſary for the intire decompoſition of Nitre to be as 1 to 7,57 or in other words that 13,21 parts Charcoal decompoſe 100 of Nitre,* and yet, even in this experiment I find a ſmall inaccuracy, as he did not take the Water employed in mixing the Nitre and Charcoal, into the account; and hence, and for ſome other reaſons, the detail of which would lead me too far, I think the proportion ſhould be as 1 to 7,868 nearly, or that 12,709 Charcoal decompoſe 100 of Nitre, but the difference is of little importance.

This mode of experimenting however is inapplicable on the preſent occaſion, the different Species of Mineral Coal being not ſo readily inflammable as to carry on the combuſtion in this manner. Hence I contented myſelf with the common manner, only uſing ſuch precautions as to render its reſults tolerably uniform, and repeating each experiment ſeveral times.

I examined the purity of the Nitre I employed, by Nitrated Silver, and found by the quantity of Salited Silver produced, that 480 grains of the Nitre contained 3,5 grains of common Salt, (135 grains of

* 11 Mem. Scav. Etrang. 626.

Muriated

Muriated Silver, indicating 00 of common Salt;) hence the constant quantity of Nitre I used was 483,5 grains except in the experiments on Bitumens, as I had not enough of them to expend on so large a quantity of Nitre.

The Nitre was heated barely to redness before any Coal was projected on it in a Wind furnace and a very large crucible; upon this uniform degree of heat much of the uniformity of different experiments on the same Species of Coal depends.

In my first experiments the Coals were reduced to a very fine powder, and then projected on the ignited Nitre, but I observed that by this method much more of each Species of Coal was requisite to Alkalize the standard quantity of Nitre than when it was reduced to a coarse powder, about the size of a pin's head or somewhat larger, and the reason is, that by the force of the explosion, much of the finer powder is carried off without having been in contact with the Nitre. Hence in the experiments of Mr. HIELM on the quantities of Charcoal of different woods requisite to Alkalize 100 parts of Nitre, we find these quantities to bear for the most part some analogy to their Specific Gravities, being generally smaller when the Specific Gravity of the Charcoal is lighter. Thus *:

Grains requisite to Alkalize 100 grains of Nitre

	Specific Gravity.	*1st Experiment*	*2d do*
Oak Coal . .	0,332 . .	35 . .	30
Birch Coal . .	0,542 . .	22 . .	22
Pine Coal .	0,280 . .	29 . .	20
Fir Coal . .	0,441 . .	33 . .	25
Coak . . .	0,744 . .	19 . .	

Another circumstance of great importance towards procuring just and uniform results is, that the projections of Coal should succeed each other without delay as soon as the flame ceases, for as ignited Nitre

* Schwed. Abhandl. 1781. 185

gives

gives out pure Air spontaneously, and so much the more as it is more heated, the Acid will be decomposed and the Nitre Alkalized by a quantity of Coal so much the smaller as the intervals of projection are longer. From inattention perhaps to this and the last mentioned particular, as well as from various conditions of common Charcoal which seldom contains less than $\frac{1}{12}$ and often $\frac{1}{6}$ of its weight of moisture and absorbed Air, proceeded the various results of different Chymists with respect to the proportion of it necessary to Alkalize Nitre.

It is almost superfluous to add that the Charcoal should be projected in very small portions. I seldom projected more than one or two grains at a time; each operation lasted from 20 to 25 minutes nearly.

There is always some portion of Nitre un-decomposed, being protected by the surrounding Alkali, this error is unavoidable but very small. Even the position of the crucible in the Furnace is not indifferent, for if it be near the Flue more Coal must be employed, which I attribute to the torrent of Air which in that case affects, and carries away more than when the crucible is nearer to the anterior part of the Furnace.

It may perhaps be suspected that this and some other incidental errors may be avoided by previously mixing the Nitre and Coal, and projecting the mixture in small portions into a Red hot crucible; but not to mention that this method supposes the due proportion of these two substances to be known, which cannot be till after the experiment, and that also every atom of these substances is in perfect contact with the other substance, else they cannot act on each other, independantly, I say of these unfounded suppositions, this mode of experimenting is still more fallacious than the former, as, during these projections a considerable proportion of the Nitre is scattered and dispersed, and may be seen adhering to the sides of the crucible, this loss being repeated at every projection becomes at last intolerable.

I now proceed to relate the experiments themselves, conducted in the manner I have mentioned. The different Species of Coal and Bitumen whose composition I have thus examined were, Kilkenny Coal, Maltha,

 Asphalt,

Asphalt, Lancashire, Cannel, Slaty Scotch Cannel, Whitehaven, Wigan, Swansey and Leitrim, selecting of each sort the purest Specimens free from Pyrites and visible stony matter.

KILKENNY COAL.

Its colour is BLACK, and when fresh broken frequently VIOLET.

Lustre 4, Metallic. Transparency 0.

Fracture, Foliated the course of the Lamellæ variously and confusedly directed. Fragments rather sharp and often discovering between the distinct concretions whitish illinitions.

Hardness 7. Specific Gravity 1,526.

Does not burn until wholly ignited, and then slowly consumes without caking or emitting flame or smoke. 266 grains of it exposed to a heat of 27° WEDGWOOD, in a crucible for five hours did not lose their Lustre until almost $\frac{9}{10}$ of them had disappeared, and at last left reddish Ashes amounting to 7,13 grains, nearly 2,7 per cent. Projecting this Coal in fine Powder on 480 grains of pure ignited Nitre, I found the Salt required 65 grains of the Coal to Alkalize it, but only 50 grains when in coarse Powder, and in a third experiment, when the crucible was farther from the flue of the furnace, only 40 grains so that I look upon 50 grains as being in round numbers nearest to the truth. That is in the proportion of one part of Kilkenny Coal to 9,6 of Nitre. Or 100 parts of Nitre require for their de-composition 10,416 of Kilkenny Coal.

This proportion of Coal is much smaller than that of Charcoal in Mr. LAVOISIER's Experiment, which we have seen to be as 1 to 7,57 or as 13,21 to 100; which I attribute to the advantageous mode in which his experiment was instituted as already explained; whereas in mine, and the usual way, the de-composition of Nitre is promoted by the external heat applied, as well as by the Coal, and consequently less of the Coal is employed.

From the experiments of SCHEELE one might be led to infer that the proportions of Charcoal and Nitre neces-

fary

fary to the Alkalization of this latter, approach ftill nearer to each other than in LAVOISIER's ftatement, and confequently much nearer than in mine; for in his Effay on Plumbago he tells us that five parts Nitre are SUFFICIENT to confume one of Charcoal, and confequently it fhould feem that one part Charcoal fhould de-compofe no more than five of Nitre; the confequence however is not juft, for undoubtedly five parts Nitre would confume one of Charcoal, but it does not thence follow that they would not confume ftill more. On the other hand he found that ten parts Nitre were NECESSARY for the confumption of one part of Plumbago, whence it follows that one part of Plumbago de-compofes ten of Nitre, otherwife nine parts Nitre would fuffice to confume it, and the tenth would have been unneceffary as it acts only as it is de-compofed. Now this proportion approaches very nearly to my refult, namely one of Charcoal to 9,6 of Nitre.

Hence, and fince Kilkenny Coal in the preceding experiments fhewed no fign of its containing any thing Bituminous, I take it for granted, that it confifts almoft intirely of pure Carbon; and fince 50 grains of it Alkalize 480 grains of pure ignited Nitre, that in all the fubfequent experiments on other Species of Coals or Bitumens free from Sulphur and Iron, the de-compofition of this ftandard quantity of Nitre will indicate in the quantity of Coal neceffary for that de-compofition, the prefence of 50 parts of mere Carbon.

Before I proceed to the recital of other experiments I muft mention another circumftance that occurs in making them, which is, that after the inflammation ceafes, a hiffing noife is perceived for a long time, and is increafed on adding frefh quantities of Coal, even when the Nitre is feemingly de-compofed; this feemed to me to arife from the de-compofition of the Nitrous Air or Mephitized Nitrous Acid, of which a portion is always retained by the Alkali, and confequently I paid no attention to it, but always ceafed adding Coal when the inflammation totally ceafed.

MALTHA.

Its colour is dark brown or black.

Lustre 0. Transparency 0. Fracture UNEVEN tough. Specific Gravity 2,070 . .

It feels somewhat greasy, yields to compression, has a heavy smell, acquires a polish when scraped, does not adhere to the tongue, or stain the fingers, its flame high and bright, leaving no Coal but only a little Ashes.

Having but a small quantity of this substance, I on this occasion used only 240 grains of Nitre; when it was heated to redness I threw on it one grain of VEGETABLE Pitch, it immediately inflamed, but floated quietly on the surface of the Nitre, and decrepitated like common Salt, from the moisture it contained; the flame was partly WHITE, from the action of the Air spontaneously emitted by the Nitre, and partly YELLOWISH from the action of the ambient Atmospheric Air, but steady and unattended with those turbulent gushes that attend the de-composition of Nitre by Carbonaceous substances.

I then gradually projected on it 55 grains of Maltha, which was all I had, this burned just as the Pitch, but attended with a blacker smoke, yet the Nitre was so far from being Alkalized, that, to produce this effect I was obliged to throw on it 29 grains of Cannel Coal.

Now 33,5 grains of Cannel Coal, if it alone had been used, would suffice to Alkalize 240 grains of Nitre as will presently be seen, therefore the 55 grains of Maltha and the one grain of Pitch contained no more Carbon than 33,5—29=4,5 grains. Therefore 100 grains of Maltha contain no more than 8 grains of Carbon. And as these 8 grains of Carbon provoked no turbulent eruption of Air from the Nitre, it is plain they did not contribute to its de-composition, but were taken up by the Air it spontaneously emitted, and partly by the ambient Atmospheric Air.

ASHPHALT.

ASPHALT.

Its colour is greyish Black. Lustre 2. 3. greasy. Transparency 0.

Fracture perfectly Conchoidal. Hardness from 7 to 8. very brittle. Specific Gravity from 1,07 to 1,165 by my trials. It feels smooth, but not greasy, has no smell, except while pounding; does not stain the fingers; when heated it melts, swells and at last inflames, but it requires for inflammation a higher heat than Maltha does, and leaves no Coal and scarce any Ashes.

Of this Bitumen I found 161 grains requisite to Alkalize the standard quantity of Nitre, it visibly educed Air from the Nitre, for there were eruptions from time to time, I suppose when the more oily part was consumed and the Carbonaceous laid bare, much of the flame was also yellowish. Hence 161 grains of Asphalt contain only 50 of mere Carbon, that is nearly 31 per cent.

Mr. THORY, burning it in a low heat, found it to leave about [illegible] of its weight of Coal after melting swelling and inflaming as usual;* however his Asphalt was not perfectly pure, as he obtained Sulphur from it.

CANNEL COAL

Its colour is black. Lustre 2. Common, when fresh broken often barely 1. Transparency 0.

Cross Fracture conchoidal. Fragments rather sharp.

Hardness from 7 to 8. Specific Gravity by my trials 1,252. by Dr. WATSON's 1,273. does not stain the fingers, easily kindles without melting and burns with a large bright flame, but of short duration, leaving a large coaly residuum, does not cake. 240 Grains of it heated until all the Coaly part was consumed left 7,5 grains of reddish brown Ashes mostly Argillaceous, that is 3,12 per cent

* 6 Crell's Chy Jour 62.

16,5

66,5 Grains of it were sufficient to Alkalize the standard quantity of Nitre. It burned with a large bright flame except the last portion which was yellowish, the pure Air of the Nitre being then exhausted. Hence 66,5 grains contained 50 of pure Carbon, and 2,08 of Ashes, then deducting 52,08 from 66,5 we find the quantity of Bitumen equal 14,42 Then 100 parts of it contain 75,2 of Carbon 21,68 Bitumen of the sort called Maltha, and 3,1 of Ashes.

I take this Bitumen to be MALTHA from its quick Inflammability and the short duration and brightness of its flame, both which properties indicate the most inflammable of the Bitumens and whose flame is least durable, from its refusal to cake, (caking being a property arising from the fusion of Asphalt) and the difficult combustibility of the Carbonaceous substance that remains after the cessation of its flame, qualities that counter-indicate ASHPHALT.

SLATY CANNEL COAL.

That which I employed was from AYRSHIRE in SCOTLAND, the only one of this sort imported to DUBLIN.

Its colour is black.

Its Lustre 2. Common. Transparency 0.

Its Fracture partly slaty, partly imperfectly conchoidal. Fragments sharp.

Its Hardness from 5 to 8. Specific Gravity 1,426 by my trials.

It burns like the compact Cannel, but ceases sooner to flame. Does not cake; leaves a stony residuum. 240 grains of it treated as before mentioned leave 50 of reddish grey Ashes, equal 20,83 per cent. From the smell that issues from it during ignition I am led to think it contains some portion of Sulphur.

To Alkalize 480 grains of Nitre 105 grains of this Coal were employed It burned like the former with a large white continued flame, except the last portions. Hence this quantity contained 50 grains of mere Carbon; and since it also contained 20,83 of Ashes,

the

the remainder, viz. 34,15, muſt have been Bitumen. Then 100 parts of it contain 47,62 of Carbon, 32,52 of Bitumen, and about 20 of Aſhes. Some deduction however from theſe quantities of Carbon and Bitumen may be made by reaſon of the ſmall proportion of Sulphur contained in it. This Bitumen I take to be Maltha and not Aſphalt, for the reaſons I mentioned in treating of compact Cannel.

It is from a Coal of this ſort that Lord DUNDONALD extracts his Tar, as Maltha eaſily diſtills; but it is probably of a better kind, as this ſtony kind exiſts moſtly in AYRSHIRE.

By his Lordſhip's mode of diſtillation however much ſeems to be loſt during the internal combuſtion. I ſhould think the Prince of NASSAU SAARBRUCK's method in this reſpect more advantageous. Mr. SAGE tells us that by diſtillation he obtained from Cannel Coal $\frac{1}{4}$ of its weight of Tar *; but Mr. FAUJAS, who uſes Lord DUNDONALD's method, obtains from the Coal of DECISE, which ſeems to be of this kind, only 4 per cent. of Tar†. FAUJAS alſo obſerved that this Tar is gradually converted into Aſphalt by long expoſure to the Air, which confirms the difference I have eſtabliſhed between the two Bitumens.

WHITEHAVEN COAL.

Its colour is black.

Its Luſtre 3. greaſy. Tranſparency 0.

Its Fracture plane foliated. Its fragments 2. Often diſcovering quadrangular or cubic diſtinct concretions, ſometimes interſected with browniſh red flakes.

Its Hardneſs 6. very brittle. Specific Gravity 1,257 by my trials. Stains the fingers, particularly when moiſt.

It burns at firſt with a clear flame, and for a long time, but at laſt cakes. 240 grains of it after five

* Roz. Jour. p. 387

† 27 Roz. Jour. p. 188

hours

hours ſtrong heat left only 4 grains of reddiſh Aſhes, or about 1,7 per cent.

The ſtandard quantity of Nitre was Alkalized by 88 grains of this Coal. Hence 100 grains of it contain nearly 57 of mere Carbon, 41,3 of a mixture of Maltha and Aſphalt, and 1,7 of Aſhes. That it contains both Maltha and Aſphalt is evident from its [illegible] and caking. The proportion I cannot exactly aſcertain, but moſt probably the Aſphalt predominates.

WIGAN COAL.

Its colour is black.

Its Luſtre 3. greaſy. Tranſparency 0

Its Fracture plane foliated. The lamellæ, ſome uniformly ſome promiſcuouſly directed. In the groſs often ſlaty. Forms ſeparate concretions, often with bright yellowiſh illinitions.

Its Hardneſs 6. Specific Gravity 1,268 by my trials.

It burns with a bright flame, and quicker than the foregoing, and is leſs apt to cake. 328 grains of it expoſed as the former to a ſtrong heat left 5,13 grains of Aſhes, that is 1,57 per cent. 81 grains of it decompoſed 480 grains of Nitre. Hence 100 grains of it contain 61,73 of Carbon, 36,7 of a mixture of Maltha and Aſphalt, and 1,57 of Aſhes.

It ſeems to contain a larger proportion of Maltha with reſpect to its quantity of Aſphalt than Whitehaven Coal does.

SWANSEY COAL.

Its colour is black.

Its Luſtre 2. Tranſparency 0.

Its Fracture foliated, but ſome Lamellæ being at right angles with the other give it a fibrous or ſtriated appearance. Fragments 2.

Its Hardneſs 5, very brittle. Specific Gravity 1,357 by my trials.

It

It burns more ſlowly than the former and cakes.

240 grains of it treated as the former kinds left 8 grains of yellowiſh red Aſhes; that is equal 3,33 per [redacted]

Of this Coal 68 grains were requiſite to de-compoſe 480 grains of Nitre. Then 100 grains of it contain 73,53 of Carbon, 23,14 of a mixture of Maltha and Aſphalt, and 3,33 of Aſhes. The Aſphalt ſeems to predominate.

LEITRIM COAL.

Its colour is black.

Its Luſtre when freſh broken 3. Tranſparency 0.

Its Fracture foliated. Its Fragments 2.

Its Hardneſs 6. very brittle. Specific Gravity 1,351 by my trials. It ſlightly cakes.

240 grains of it left after three hours expoſure to heat 12,5 grains of reddiſh grey Aſhes, that is equal 5,2 per cent.

The de-compoſition of the ſtandard quantity of Nitre required 70 grains of this Coal. Hence 100 grains of it contain 71,43 of Carbon, 23,37 of a mixture of Maltha and Aſphalt, and 5,2 of Aſhes.

NEWCASTLE COAL.

I had none of this kind of Coal, but according to Doctor WATSON's experiment it left on diſtillation a coaly reſiduum amounting to 58 per cent. and hence contained about 40 of a mixture of Aſphalt and Maltha, in which the former appears to predominate. Hence it much reſembles the Whitehaven Coal, but it evidently contains Sulphur alſo, which that of Whitehaven ſeldom does.

A Synoptical View of the Contents of BITUMENS and different Sorts of MINERAL COAL.

100 Parts	Carbon.	Bitumen.	Ashes.	Speci. Grav.
Maltha - -	8	—	—	2,070*
Asphalt -	31	68	—	1,117
Kilkenny - -	97,3	—	3,7	1,526
Compact Cannel	75,2	21,68 Maltha	3,1	1,232
Slaty Cannel -	47,62	32,52 Maltha	20	1,426
Whitehaven -	57	41,3 mixt	1,7	1,257
Wigan - -	61,73	36,7 mixt	1,57	1,268
Swansey - -	73,53	23,14 mixt	3,33	1,357
Leitrim - -	71,43	23,37 mixt	5,20	1,351
Newcastle -	58	40 mixt	—	1,271

To these results I shall add a few more, taken from a Treatise on Pit Coal lately published by Signior FABRONI. The Italian Coals were examined by himself; the French and German by other Chymists. All by distillation.

* *probably* 1,07.

100

100 Parts	Carbon.	Bitumen.	Ashes.	Specific Gravity.
Coals of Halles -	86	12	—	—
of Tudertino	25	75	—	—
of Cortolla -	45	43	12	1,403
of Macinaia	60	37	3	1,411
Stony of do.	12,5	37,5	50	1,666
of Mocaio.	32	35	33	1,403

These Coals contain very little Asphalt, but chiefly Maltha.

Most Coals afford a volatile Alkali by distillation; this seems to me to be rather a product of the operation arising from the union of Hydrogen and Mephitic Air, and thus the Alkaline basis of the Ammoniacs found on volcanos seem to have been formed. Coals also afford an Acid, commonly the Marine, or if Pyritous, also the Vitriolic, more rarely the Succinous.

According to Mr. JARS, 100 parts of the best English Coal give when chared 63 of COAKS*, but HIELM found the residuum of the best English Coals distilled to amount to 73 per cent. and Doctor WATSON found the residuum of NEWCASTLE Coal to amount only to 58 per cent. These results necessarily differ according to the degree of heat applied, the duration of the combustion and the variable admission of Air. It is plain the Bitumen is never totally expelled, at least not until most of the Carbon is consumed; but much more of it is expelled by combustion than by distillation, 3 WATSON, p. 27 and 28.

* 1 Jars. p. 329.

F I N I S.

[redacted]

[redacted]